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ABSTRACT

This teaching guide for business machine repair occupations is one of a series of five performance- and employer-based secondary level vocational education guides. Part 1 provides tools, resources, and a process to be used at the local level to develop a training curriculum and supporting instructional activities. It includes a comprehensive overview of the career field; a performance-based listing of job tasks and related learning objectives; a method for developing learning activity packages; two sample learning activity packages; descriptions of eight commonly used teaching methods; and a listing of instructional resources and references. Part 2 offers the guidance counselor career information and recommends steps to determine criteria for student selection and placement in the training program; a description of the general aptitude test battery; a composite profile of the entry-level worker; a listing of instructional units of a widely used remediation program; the Worker Trait Codification System (from the "Dictionary of Occupational Titles") which provides an explanation of the knowledge, aptitude, and interest levels associated with worker trait groups; descriptions of related jobs; and job titles associated with the worker trait groups identified for the entry-level worker.
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TEACHING GUIDE FOR BUSINESS MACHINE REPAIR OCCUPATIONS

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TABLE OF CONTENTS

	Page
Preface	v
PART ONE: Guide for Curriculum and Instructional Development	
SECTION 1.1: How to Use Part One of the Guide	3
SECTION 1.2: How the Guide Was Developed	6
SECTION 1.3: General Job Description: Business Machine Repairer	8
SECTION 1.4: Inventory of Job Tasks and Learning Objectives	11
SECTION 1.5: How to Develop Learning Activity Packages	28
SECTION 1.6: How to Select an Instructional Method	83
SECTION 1.7: Teaching-Learning Resources for the Instructor	94
PART TWO: Guide for Student Selection and Placement in the Training Program	
SECTION 2.1: How to Use Part Two of the Guide	105
SECTION 2.2: Career Guidance for Business Machine Repair Occupations	106
SECTION 2.3: Qualifications Profile for the Entry-Level Business Machine Repairer	110
SECTION 2.4: The Advanced General Education Program	114
SECTION 2.5: Worker Trait Codification System	119
SECTION 2.6: Related Jobs at Entry, Intermediate, and Advanced Levels	127
SECTION 2.7: Related Jobs by Worker Trait Group	133

PREFACE

The teaching guide for business machine repair occupations is linked to a national vocational information system which is performance-based and employer-based. It offers the instructor, guidance counselor, student, and administrator the results of an occupational analysis of the career field and presents a core of resources that can be used to develop a training curriculum at the local level. It also provides a description of the basic competencies required for advancement within the field.

The guide presents the instructor and student with statements of the actual job skills required to perform at the entry level in the business machine repair field. For the curriculum designer, the guide provides a logical system of information—job tasks, learning objectives, a suggested instructional methodology, sample learning activity packages, and teaching resources—that is adaptable to local school needs and resources. For the guidance counselor, the guide offers information and suggestions for determining the prerequisite learning needs of individual students and recommends diagnostic tools for placing students in the training program. The school administrator can use the guide as a planning and evaluative tool to strengthen existing programs or develop new ones. All users of the guide should familiarize themselves with each section so that maximum use may be made of the guide in curriculum development efforts.

The guide is divided into two parts: Part One, "Guide for Curriculum and Instructional Development" (Sections 1.1–1.7), and Part Two, "Guide for Student Selection and Placement in the Training Program" (Sections 2.1–2.7).

PART ONE: GUIDE FOR CURRICULUM AND INSTRUCTIONAL DEVELOPMENT

SECTION 1.1, "How to Use Part One of the Guide," presents a recommended, step-by-step method for using Sections 1.1–1.7. Included in the section are steps for: Background and Review, How to Plan Your Course, How to Develop Instructional Units, and Student Selection and Placement.

SECTION 1.2, "How the Guide Was Developed," explains the structure and development of the guide and the definitions of key concepts: occupational analysis, worker trait group, task statement, task inventory, learning objective, and career ladder.

SECTION 1.3, "General Job Description: Business Machine Repairer," provides a comprehensive overview of the career field, descriptions of the type of work performed at the entry level, employment forecasts, and other important career information.

SECTION 1.4, "Inventory of Job Tasks and Learning Objectives," presents a performance-based listing of business machine repair job tasks at the entry, intermediate, and advanced levels. Also included at the entry level are learning objectives related to a task or group of tasks. The tasks represent the significant learner outcomes of the training program; they are the core materials upon which curriculum development efforts can be based.

SECTION 1.5, "How to Develop Learning Activity Packages," explains a method for developing learning activity packages from the performance-

based tasks and learning objectives. Two sample learning activity packages are presented—one based on a task and its learning objective and one on basic mathematical skills.

SECTION 1.6, "How to Select an Instructional Method," describes the uses, advantages, and disadvantages of eight of the most commonly used instructional methods and the factors involved in selecting the most appropriate method for a given learning situation.

SECTION 1.7, "Teaching-Learning Resources for the Instructor," provides the instructor with a variety of instructional resources and references for use in curriculum and instructional development efforts.

PART TWO: GUIDE FOR STUDENT SELECTION AND PLACEMENT IN THE TRAINING PROGRAM

SECTION 2.1, "How to Use Part Two of the Guide," offers the school guidance counselor a step-by-step method for using Sections 2.2–2.7.

SECTION 2.2, "Career Guidance for Business Machine Repair Occupations," provides a theoretical framework for guidance activities in the

training program and describes the General Aptitude Test Battery which can be used for student selection and placement.

SECTION 2.3, "Qualifications Profile for the Entry-Level Business Machine Repairer," presents a composite profile of the entry-level worker and is based on worker traits associated with this career field from the Dictionary of Occupational Titles.

SECTION 2.4, "The Advanced General Education Program," lists the instructional units contained in a widely used remediation program.

SECTION 2.5, "Worker Trait Codification System," is excerpted from the Dictionary of Occupational Titles and provides an explanation of the knowledge, aptitude, and interest levels associated with worker trait groups.

SECTION 2.6, "Related Jobs at Entry, Intermediate, and Advanced Levels," is included in the guide to suggest the job and career mobility that results from training in business machine repair.

SECTION 2.7, "Related Jobs by Worker Trait Group," presents job titles associated with the worker trait groups identified for the entry-level worker.

PART ONE

**GUIDE FOR CURRICULUM
AND
INSTRUCTIONAL DEVELOPMENT**

SECTION 1.1

How to Use Part One of the Guide

Part One of the guide provides tools, resources, and a step-by-step process that can be used at the local secondary school level to develop a business machine repair training curriculum and supporting instructional activities. The steps listed below present a recommended method for using the sections in Part One of the guide. The user is encouraged to follow these steps so that the best possible use of the guide can be made.

The **Background and Review** steps provide the user with a comprehensive overview of the business machine repair field and an explanation of the procedures used to develop the guide. The steps included in **How to Plan Your Course** offer a detailed procedure for using key sections of Part One to develop an up-to-date, job-related curriculum. The steps under **How to Develop Instructional Units** build on the course-planning steps and provide useful models for the development of learning activity packages which are responsive to local needs. The **Student Selection and Placement** steps offer suggestions to the instructor for coordinating course development activities with the school guidance counselor's student selection and placement activities.

BACKGROUND AND REVIEW

STEP 1: Review how the guide was developed. Read Section 1.2, "How the Guide Was Developed," to gain a thorough understanding of the structure and development of the guide and to become familiar with these key concepts and terms: occupational analysis, worker trait group, task statement, task inventory, learning objective, and career ladder.

STEP 2: Review the information on the business machine repair field. Read Section 1.3, "General Job Description: Business Machine Repairer,"

for an overview of the career field, descriptions of the type of work performed, employment forecasts, and other important career information.

STEP 3: Review the Inventory of Job Tasks and Learning Objectives. Study Section 1.4, "Inventory of Job Tasks and Learning Objectives," to gain another perspective on the career field. This section presents a performance-based listing of business machine repair job tasks at the entry, intermediate, and advanced levels and the entry-level learning objectives. The tasks represent the significant learner outcomes of the training program and are the core materials upon which curriculum development efforts can be based.

HOW TO PLAN YOUR COURSE

STEP 1: Examine each entry-level task and its associated learning objective. The entry-level tasks and objectives form the building blocks of a performance-based curriculum. Consider what is meant by each task and objective statement listed in Section 1.4, how it differs from other statements in the inventory, and how it relates to: the needs of your student population; the educational priorities of your school; the facilities, equipment, and instructional materials available; and the time available for instruction.

STEP 2: Rank the tasks and objectives in the order of their importance. Keeping in mind the educational priorities, needs, and resources of your school and students, rank all the entry-level tasks and objectives in the order of their importance. Your first efforts should be to divide the tasks and objectives into more manageable clusters, such as: 1 = most important, 2 = average importance, and 3 = less important. Then, rank

the tasks and their objectives within each of these clusters. The end result of this effort is a ranked list of task and learning objective statements ranging from most important to least important with regard to your educational priorities, needs, and resources. If several people or an advisory committee are involved in course planning, their ranking of the inventory should be done independently.

STEP 3: Independently rerank the tasks and objectives. After a short period of time has elapsed (one or two weeks), all of the people who ranked tasks and objectives should repeat Steps 1 and 2. Do not refer to your initial rankings during this step.

STEP 4: Resolve any differences in the rankings. In order to improve the reliability of the rankings, resolve any differences through group discussions among the rankers and a re-examination of the tasks and their associated objectives.

STEP 5: Review your ranked entry-level list. For the finalized, ranked list of tasks and objectives, determine if you have a manageable number to teach in the time allotted for the training program. Drop the lowest-ranked statements until a manageable number is reached.

STEP 6: Sequence your entry-level task and objective list. Sequence the tasks and objectives in the approximate order in which they will be taught. (The sequence may be slightly altered when you begin developing instructional units.) There are two basic ways to sequence learning: one is based on the order in which the tasks are performed on the job, and the other is based on a building block concept. These two methods are described in more detail below. In actual practice, both sequencing methods have their place in course development. Deciding which method to use will depend on the content and performance required in a particular task or group of tasks.

• **Method 1: Job Performance Order.** This method provides the student with training in performing a group of tasks as they actually would be performed on the job. The sequence may be determined through employer interviews, the establishment of an occupational advisory committee, or collaboration with local training directors or supervisors.

• **Method 2: Building Block Learning.** The building block method means that the initial, prerequisite skills and knowledge taught serve as basic building blocks for subsequent instruction. In general, a student should progress from the simple to the complex, from the familiar to the unfamiliar, and from the concrete to the abstract. Easily learned tasks or broad concepts that have application throughout the course should be placed at the beginning of the course. Similarly, more complex tasks that depend on the mastery of several simpler tasks should be placed near the end of the course.

STEP 7: Contact business machine repair personnel in your local area. In your course planning you should acquaint local business machine repair personnel with your course of studies, approach, and instructional activities. They may be able to provide some useful suggestions about involving students in cooperative education programs, volunteer projects, and field trip activities.

HOW TO DEVELOP INSTRUCTIONAL UNITS

STEP 1: Review the basic principles of learning. In Section 1.5, "How to Develop Learning Activity Packages," a list of basic learning principles is presented. Review the list to gain an understanding of these principles which support all types of learning activities. The principles can be applied to instructional units based on the tasks and learning objectives you selected.

STEP 2: Examine the process for developing learning activity packages. Study Section 1.5 to become familiar with the process used to develop learning activity packages which utilize the performance-based tasks and learning objectives. Section 1.5 provides two sample learning activity packages—one based on a task and its associated learning objective and one based on the mathematical skills of approximation and estimation.

STEP 3: Develop your own learning activity packages. Design your own packages based on the process described in Section 1.5. Blank worksheets are provided at the end of Section 1.5 for this purpose.

STEP 4: Select methods of instruction and supporting activities. Use Section 1.6, "How to Select an Instructional Method," and Section 1.7, "Teaching-Learning Resources for the In-

structor," to support the teaching of each learning activity package.

STUDENT SELECTION AND PLACEMENT

STEP 1: Review the guidance sections in Part Two of the guide. Review the sections in Part Two of the guide to gain an understanding of how the guidance activities relate to and support your curriculum and instructional development activities. It is especially important to review Section 2.3, "Qualifications Profile for the Entry-Level Business Machine Repairer."

STEP 2: Coordinate your efforts with the school guidance counselor. Discuss student selection and placement activities with the school guidance counselor in order to establish criteria for selection and placement of students in the business machine repair training program.

SECTION 1.2

How the Guide Was Developed

The teaching guide for business machine repair occupations represents a significant step in the development of training programs that are closely linked with employer requirements and employment opportunities. It is based on the premise that students should be trained in the actual job skills identified by business machine repair personnel and institutions for entry-level positions. Its aim is to put into the hands of educators at the local level a core of materials that can be used to develop a training program based on their needs and resources. This section of the guide describes the procedures used to develop the teaching guide and provides the background information needed for effective use of each section.

Development of the teaching guide began with the identification of a family of jobs within the field which were related through their required levels of performance and knowledge. Extensive use was made of the Dictionary of Occupational Titles (D.O.T.),* U.S. Civil Service Commission documents, and related supplements in identifying job families.

The criteria used for selecting jobs that would, in effect, define the field included:

Broad Entry-Level Tasks. Jobs were selected which required the performance of a broad range of entry-level skills and knowledge when compared to related jobs.

Job Mobility. Jobs were selected that entailed skills and knowledge which could be applied to jobs higher on a career ladder concept beginning at the semi-skilled or entry level and proceeding upward, job by job, to the advanced level. Jobs

that did not provide an opportunity for upward mobility within the career field were screened out.

Career Flexibility. Job skills and knowledge which could be applied to jobs outside the field were selected. This criterion reflected concern for students who might partially or entirely finish the training program and then decide to enter another career field.

Future Employment Opportunities. Available employment forecasts were used to select jobs for inclusion in the job family for which there was an anticipated need nationwide.

Training Time Requirements. Jobs were selected for which entry-level training could be completed within a two-year program.

Training Flexibility. Jobs were screened in terms of their projected training cost, support requirements, and facilities required.

After this composite picture of the business machine repair field had been produced by defining a representative family of jobs, title jobs were selected to represent the job family at the entry, intermediate, and advanced levels of performance. Encompassing the broadest range of skills and knowledge within the job family, the title jobs chosen were: business machine repairer (entry level), business machine technician (intermediate level), and business machine service manager (advanced level).

The next step involved generating a list of tasks and associated learning objectives to represent the basic skills and knowledge required at the entry level. This step was based on a careful analysis of the D.O.T., U.S. Civil Service Commission job grading standards, employer interviews, and an evaluation of existing inventories of business machine repair tasks and learning objectives. The inventories appearing in this

* U.S. Department of Labor. Dictionary of Occupational Titles (Vol. 1, Definition of Titles; Vol. 2, Occupational Classification) (3rd ed.). Washington, D.C.: U.S. Government Printing Office, 1965.

guide are the result of this analysis and evaluation. The entry-level tasks for business machine repair are categorized under six generic headings which correspond to the major topical areas that a trainee will need to cover in the training program. By mastering these broad-based tasks, the trainee is provided with a strong foundation for on-the-job training in repairing and maintaining all types and specific models of business machines.

In support of the entry-level inventories, task statements were compiled and evaluated at the intermediate and advanced levels. The higher-level task inventories indicate the competencies and knowledge required as the worker progresses up the career ladder. All three task inventories (entry, intermediate, and advanced) are conceived as a core of job performance skills which can be adapted to local educational needs and available school resources.

The final task and learning objective inventory at the entry level (and the intermediate and advanced task inventories) in Section 1.4 are the bases from which the other sections of the guide were developed: the general job description, the recommended methodology for creating learning activity packages, and the strategies and diagnostic tools available for placing students in the training program.

The methodology used in developing the teaching guide has several important implications for curriculum development efforts. First is the close link established between curriculum intent and instructional practice. If the recommended procedures for developing learning activity packages are followed, relevance of the instructional content is guaranteed since the occupational analysis produced only the essential, as opposed to the "nice-to-know," tasks and objectives required for acceptable job performance. No matter which tasks and objectives the instructor selects from the inventories, the resulting curriculum content relates to the capabilities derived from the occupational analysis.

Second, since the analysis produced many more tasks than a two-year curriculum could logically utilize, the final set of instructional units is determined at the local level by the instructor, who is in the best position to make such decisions. The instructor's selection of tasks and objectives from the entry-level inventory is made on the basis of identified local employment opportunities, students' needs, and resources available. Consequently, the teaching guide represents a flexible set of materials that can be revised and updated in response to the changing requirements of the career field.

SECTION 1.3

General Job Description: Business Machine Repairer

The General Job Description provides instructors, career guidance counselors and students with an introduction to the career field of business machine repair. The information contained in this section* includes an overview of the career field, specific descriptions of the type of work done in the business machine repair field, places of employment, training requirements, employment forecasts, expected earnings, working conditions, and sources of additional career information.

NATURE OF THE WORK

Business machine repairers maintain and repair the machines that are used to speed the paperwork in business and government. These include typewriters, adding and calculating machines, cash registers, dictating machines, postage meters, and duplicating and copying equipment. (Workers who service and repair computers are described in a separate job classification in the Occupational Outlook Handbook.)

Repairers often work in offices where the machines are used. They may maintain equipment by regular, frequent visits to inspect, clean, and oil the machines, or to make minor repairs or adjustments. When machines break down, they diagnose and correct the cause of the trouble. Often business machine repairers locate the problem and make repairs on the spot. For major repairs, however, they usually take machines to the shop. Many workers in this field repair a

variety of machines; others specialize in only one or a few types. For example, specialists usually service duplicators, copiers, postage meters, and mailing equipment.

Business machine repairers use common handtools, such as screwdrivers and pliers, and test equipment, such as gauges and meters. In large shops, they use drill presses, lathes, and other power equipment.

Business machine repairing and servicing offers a great variety in work assignments. People who have analytical ability find considerable satisfaction in finding and correcting the cause of trouble in a faulty machine. Some may also do sales work. Most commonly, they sell preventive maintenance contracts for regular machine servicing. Some also sell supplies, such as special paper, ink, ribbons, and stencils.

PLACES OF EMPLOYMENT

About 70,000 people worked as business machine repairers in 1972. A small number were women. About three-fourths of these business machine repairers worked mainly on typewriters, calculators and adding machines, and copiers and duplicators. Most of the rest repaired and serviced accounting-bookkeeping machines, cash registers, and postage and mailing equipment. A small number repaired dictating machines.

Most people in this field worked for business machine manufacturers, dealers, and repair shops. The remainder worked for federal, state and local governments, and large organizations that had enough machines to justify full-time work.

In a manufacturer's branch office, repairers usually work exclusively on the manufacturer's products. They specialize in one or two machines or service the full line of equipment.

* This section has been excerpted from the Occupational Outlook Handbook (1974-75 Edition), U.S. Department of Labor, Bureau of Labor Statistics, Bulletin 1785, and from "Job Grading Standard for Office Appliance Repairer (WG-4806)," U.S. Civil Service Commission, Bureau of Policies and Standards, TS-9.

In a small city, specialization is impractical so most workers repair and sell all kinds of equipment.

Business machine repairers work throughout the country. Even relatively small communities usually have at least one or two repair shops. Most, however, work in large cities.

TRAINING, OTHER QUALIFICATIONS, AND ADVANCEMENT

Applicants for entry jobs as business machine repairers usually need at least a high school education. Some companies accept young people who have not completed high school. Employers like to employ veterans who have had electronics training in the Armed Forces. Applicants who are interested in working on electronic equipment must have one year or more of training or experience in electronics.

Applicants for entry-level jobs may have to pass tests that measure mechanical aptitude, knowledge of electricity or electronics, manual dexterity, and general intelligence. Good eyesight, including color vision, is needed.

Employers seek applicants who have a pleasant, cooperative manner. Because most machine repairing and servicing is done in customers' offices, the ability to work without interrupting the office routine is very important. A neat appearance and ability to converse effectively also are desirable.

Some employers require that business machine repairers be bonded. Applicants for these jobs must be honest and trustworthy since they are exposed to large sums of money and other valuables in banks and offices. Workers also may collect money from customers for services and supplies.

Beginners generally acquire skills through on-the-job training, work experience, and instruction in manufacturers' schools. Some vocational and private correspondence schools conduct courses in business machine maintenance for trainees

and others. In addition, programs to train unemployed workers as office machine repairers and servicers were operating in several cities in 1972 under the provisions of the Manpower Development and Training Act.

Business machine repairers who work in a manufacturer's branch office learn to repair only the company's line of machines. Trainees usually attend company schools from a few weeks to several months, depending on the type of machine they will service. They then receive from one to three years of practical experience and on-the-job training before they become fully qualified. Occasionally, they may return to factory schools for special instruction in new business machine developments. Workers are encouraged to broaden their technical knowledge during nonworking hours. Many companies pay the tuition for work-related courses in college and technical schools.

Business machine repairers may move into sales positions for greater earnings. Those who show exceptional abilities also may advance to foreman, service manager, or supervisor. Experienced workers sometimes open their own repair shops; those who work in manufacturers' branch offices sometimes become independent dealers or purchase sales franchises from the company.

EMPLOYMENT OUTLOOK

Employment of business machine repairers is expected to grow very rapidly through the mid-1980s. In addition to jobs from employment growth, many openings will arise as experienced workers retire, die, or change occupations.

Business and governments will buy more machines to handle the growing volume of paperwork and more workers will be needed to maintain and repair these machines. In recent years, many technical changes have occurred in long-established types of business machines. For example, electronic calculating machines have replaced mechanical models. Because of the greater use of such equipment, opportunities will be particularly favorable for those who have training in electronics.

Business machine repairers work year-round and have steadier employment than many other skilled workers. Office machines must be maintained, even when business slackens, since records must be kept, correspondence carried on, and statistical reports prepared.

EARNINGS AND WORKING CONDITIONS

Information obtained from a limited number of employers in 1972 indicated that experienced business machine repairers generally earned from \$150 to \$250 a week. Wages depend on geographic location, machine serviced, and the length of employment. Wages generally were lowest for workers who repair only typewriters, adding machines, calculators, cash registers, or dictating machines. Rates usually were highest for the repair of accounting-bookkeeping machines, postage and mailing machines, and complex duplicating and copying equipment.

New trainees earn from \$110 to \$160 a week. As they become more skilled, their pay increases. People who have previous electronics training in the Armed Forces or civilian technical schools generally receive somewhat higher beginning wages.

In addition to salaries, business machine repairers in some companies receive commissions for selling supplies or service contracts. Many employers pay all or part of life and hospitalization insurance and pension plans.

Servicing and repairing business machines is cleaner and lighter than the work in most other

mechanical trades. Workers generally wear business suits and do most of their work in the offices which own the machines. Injuries are uncommon. Some positions involve considerable traveling within the area served by the employer. Workers who use their own cars for company business are reimbursed on a mileage basis. Employers usually pay for all tools.

SOURCES OF ADDITIONAL INFORMATION

For more details about job opportunities contact local firms that repair business machines and the local office of the Illinois State Employment Service. They also may have information about the Manpower Development and Training Act and other training programs. Additional information about employment opportunities in this career field can be obtained from the sources listed in Section 1.7, "Teaching-Learning Resources for the Instructor."

A variety of federal agencies have assigned job designation codes to positions in the business machine repair field. These codes are commonly used by federal, state, and local governments. When requesting career information, it may be helpful to use these code numbers:

U.S. Civil Service Designation: WG-4806

U.S. Department of Labor (D.O.T.) Designation: 633.281

Standard Industrial Classification Manual Designations: 7629, 7699

Office of Education Code: 17.0600

SECTION 1.4

Inventory of Job Tasks and Learning Objectives

This section of the guide presents the job task and learning objective inventories for business machine repair work at the entry level and task inventories at the intermediate and advanced levels. The tasks and their associated learning objectives at the entry level represent the significant learner outcomes of the training program and thus are the core materials upon which curriculum and instructional development efforts can be based.

The entry-level tasks are categorized under six generic headings: Electrical Systems, Mechanical Systems, Mechanical Maintenance, Fluid Power, Inspection and Testing, and Communications. These headings correspond to the major topical areas that a trainee will need to cover in the training program and provide him or her with a strong foundation for on-the-job training in repairing and maintaining all types and specific models of business machines.

Through an analysis of the occupational field it was established that the tasks listed under "Electrical Systems" were the most important to the potential employer. Therefore, a specific learning objective was developed for each task in this category to emphasize its importance. For the remaining five generic headings, a general learning objective was developed for the group of tasks under each heading.

At the intermediate and advanced levels, the task inventories suggest the career mobility within the field of business machine repair and the corresponding increase of difficulty and responsibility involved as one progresses up the career ladder.

Preceding each inventory is a brief overview of the title job for the entry level (business machine repairer), intermediate level (business machine technician), and advanced level (business machine service manager). The letter and number codes given for each job task statement are for identification purposes only. They should not be interpreted as sequential steps or rankings of the tasks by importance. (See Section 1.1 for task sequencing and ranking procedures.) Abbreviations used are: E = entry-level tasks, I = intermediate-level tasks, A = advanced-level tasks.

The user also should refer to Section 2.3 where a qualifications profile of the knowledge, aptitudes, interests, and temperaments required to perform the entry-level tasks successfully is presented. Section 2.5 of this guide and the Dictionary of Occupational Titles provide additional information about and detailed explanations of these worker traits.

ENTRY-LEVEL JOB TITLE: BUSINESS MACHINE REPAIRER

At the entry level the worker performs a variety of tasks involving the repair, overhaul, and maintenance of various types of standard business machines such as manual and electric typewriters, accounting machines, cash registers, mailing equipment, adding machines, calculating machines, dictation equipment, and duplicating machines. The business machine repairer receives work orders or oral instructions from a supervisor or higher-level worker outlining the work to be done. The worker locates worn, damaged, or defective parts through visual checks or operational tests. After diagnosing the malfunction, he or she disassembles the machine, makes necessary adjustments or replaces defective parts, and then cleans, lubricates, and reassembles the

machine. The worker makes a final operational check and any necessary adjustments. A higher-level worker or supervisor is available for on-the-job training related to specific types and models of business machines, assistance on unusual problems encountered, and spot-checking of work in progress. The repairer must have a knowledge of the design, basic principles, and operating characteristics of standard business machines. He or she must have the ability to identify problems and to determine what adjustments or repairs are needed. The worker must be skilled in the use of common handtools and must be familiar with manufacturers' parts catalogs and operating manuals in obtaining replacement parts and making repairs.

ENTRY-LEVEL TASKS

Electrical Systems

Task	Objective
E-1 Assemble a circuit with an ammeter in it and read the current in the circuit.	Given a power source, lamps and sockets, clip leads and an ammeter, the student will be able to assemble a circuit with an ammeter in it and read the current in the circuit within 10% of the stated results.
E-2 Assemble a circuit and read the voltage across the parts.	Given a power source, clip leads, resistor, lamp and socket, and a voltmeter, the student will be able to assemble a circuit and read the voltage across the parts within 10% of the stated results.
E-3 Read the resistance of a part using an ohmmeter.	Given two resistors, one lamp and socket, one coil of wire, and an ohmmeter, the student will be able to read the resistance of a part using an ohmmeter within 10% of the stated results.

E-4 Connect a load to an energy source and measure, calculate and record the values of resistance, voltage and amperage.

Given a fuse holder, two fuses, handtools, wire, two volt-ohm-amp meters, meter leads, diagram of circuit, and the values that should be obtained from the circuit, the student will be able to connect a load to an energy source and measure, calculate and record the values of resistance, voltage, and amperage within 10% of the values given on the diagram.

E-5 Connect a basic electric circuit and deliberately overload the circuit to exceed the design limitations of the fuse.

Given a source, load, mock-up board, ammeter, ohmmeter, and diagrams, the student will be able to connect a basic electric circuit and deliberately overload the circuit to exceed the design limitations of the fuse.

E-6 Connect a basic electric circuit and deliberately short the circuit to exceed the design limitations of the fuse.

Given a source, load, mock-up board, ammeter, ohmmeter, and diagrams, the student will be able to connect a basic electric circuit and deliberately short the circuit to exceed the design limitations of the fuse.

E-7 Measure voltages, currents and resistances with a multimeter.

Given a multimeter and a circuit with a power source and load, the student will be able to measure voltages, currents, and resistances with a multimeter within 10% of those called for in the experiment.

E-8 Connect a series circuit and measure the circuit values of resistance, voltage, and amperage.

Given a source, load, mock-up board, diagram, ammeter, voltmeter, and ohmmeter, the student will be able to connect a series circuit and measure the circuit values of resistance, voltage, and amperage so that the connected circuit and its values agree with the given circuit and its values.

E-9 Connect a parallel circuit and measure the circuit values of resistance, voltage, and amperage.

Given a diagram of a circuit, the student will be able to connect a parallel circuit and measure the circuit values of resistance, voltage, and amperage within 10% of the given circuit and its values.

E-10 Connect two series/parallel circuits and measure the circuit values of resistances, voltages, and amperages.

Given a circuit diagram, power source, three ammeters, ohmmeter, fuse holder, lamp fuse, four lamp holders, four lamps, and two switches, the student will be able to connect two series/parallel circuits and measure the circuit values of resistances, voltages, and amperages so that the connected circuits and their values agree with the given values for each circuit.

E-11 Identify all of the components in the Broadhead Garrett 210A and draw their symbols.

Given a Broadhead Garrett 210A, the student will be able to correctly identify all of the components in the Broadhead Garrett 210A and draw their symbols.

E-12 Compute the impedance and reactance of an R-C circuit.

Given an R-C circuit, an audio generator, and a VTVM, the student will be able to compute the impedance and reactance for the R-C combination circuit within 15% of the stated results for the experiment.

E-13 Use Ohm's Law to calculate the voltage, current, and resistance in a circuit.

Given a voltmeter, ammeter, power supply, and load, the student will be able to use Ohm's Law to calculate the voltage, current, and resistance in a circuit within 10% of the measured values.

E-14 Trace all of the series circuits on a schematic.

Given a schematic, the student will be able to trace all of the series circuits on the schematic.

E-15 Trace all of the parallel circuits on a schematic.

Given a schematic, the student will be able to trace all of the parallel circuits on the schematic.

E-16 Measure AC voltage using an oscilloscope.

Given a circuit with AC voltage on it and an oscilloscope, the student will be able to measure AC voltage using an oscilloscope within 5% of the stated correct measurements.

E-17 Compute the impedance and reactance of the circuit.

Given an audio generator, VTVM, and a circuit with an inductor, the student will be able to compute the impedance and reactance of the circuit within 10% of the stated results for the experiment.

Mechanical Systems

General Learning Objective: Given a mechanical system and an operating lubrication system, the student will be able to demonstrate a working knowledge of the mechanical system (including shafts, bearings, couplings, clutches, gears, belts, and chain drives), lubrication materials, and causes of lubrication failure in order to avoid mechanical failure or repair mechanical systems.

E-18 Remove and replace seals using proper tools.

E-19 Identify shaft arrangements.

E-20 Identify operational features of shafts and seals.

E-21 Remove, examine, and install bearings.

- E-22 Maintain bearings.
- E-23 Use specifications charts to select proper lubricant.
- E-24 Operate lubrication dispensing apparatus.
- E-25 Lubricate office machines.
- E-26 Remove, replace, align, and check tolerances of couplings and clutches.
- E-27 Assemble gear patterns following technical diagrams.
- E-28 Identify speed reducers and multipliers.
- E-29 Adjust gears.
- E-30 Inspect gears for defects.
- E-31 Select belts and chains for mechanical application, using catalogs.
- E-32 Remove and install belts and chains using appropriate tools.
- E-33 Remove and replace pulleys and sprockets.
- E-34 Detect malfunctioning belts and chain drive arrangements.

Mechanical Maintenance

General Learning Objective: Given appropriate maintenance techniques involved in handling system components found in business machines, the student will be able to assemble and disassemble machines according to specifications.

- E-35 Disassemble and reassemble equipment.
- E-36 Remove and replace equipment components such as lubrication system and cooling system.
- E-37 Select measuring instruments and measure required tolerances.
- E-38 Start equipment to listen to operation.
- E-39 Select proper solvents for cleaning metal or non-ferrous parts.
- E-40 Use solvents to clean metal and non-ferrous parts.
- E-41 Identify function of magnetism and motor operation.
- E-42 Select and use hand and power tools to perform maintenance tasks.

- E-43** Select and use portable power machinery to perform mechanical maintenance tasks.
- E-44** Select practical soldering and welding equipment for job requirements.
- E-45** Use soldering and welding equipment to perform minor mechanical maintenance tasks.
- E-46** Use various machine tools (e.g., buffers and grinders) to complete tasks of mechanical maintenance.

Fluid Power

General Learning Objective: Given fluid power systems, the student will be able to demonstrate the ability to diagnose and repair machine breakdowns associated with fluid power breakdowns.

- E-47** Identify hydraulics and pneumatics systems.
- E-48** Demonstrate fluid power equipment.
- E-49** Explain basic application of fluid power laws.
- E-50** Apply fluid power laws to the testing, repairing, and maintaining of fluid systems components.
- E-51** Use test bench to exhibit fluid laws in actual application.
- E-52** Utilize laboratory to reinforce fluid laws on live systems.
- E-53** Identify safety rules pertaining to fluid power equipment operation and maintenance.
- E-54** Service fluid power, filters and seals.
- E-55** Disassemble and assemble filters.
- E-56** Flow test filters.
- E-57** Conduct viscosimeter check.
- E-58** Make simple hookups on fluid power test bench to illustrate element operation in a circuit.
- E-59** Demonstrate digital and proportional devices.
- E-60** Demonstrate switching and sensing in basic circuits.
- E-61** Locate charts, manuals, and diagrams to identify symbols related to fluid power.
- E-62** Sketch component operation.
- E-63** Explain component operation in a total circuit.

- E-64** Read schematics of live equipment and follow schematics to remove and replace fluid power components.
- E-65** Disassemble and assemble fluid power components.
- E-66** Operate individual fluid power components.
- E-67** Operate total fluid power circuits.
- E-68** Test, record, and interpret data on flow, pressure, heat, and velocity.

Inspection and Testing

General Learning Objective: Given precision measuring devices, the student will be able to demonstrate skill in the operation of equipment used to inspect, test, and examine mechanical equipment so as to determine and repair machine malfunction.

- E-69** Select and use caliper to transfer measurements.
- E-70** Select and use a voltmeter.
- E-71** Select and use an ohmmeter.
- E-72** Select and use an oscilloscope.
- E-73** Troubleshoot mechanical equipment operation.
- E-74** Select and use ammeters.
- E-75** Convert units of measurements to decimals, fractions and metrics.
- E-76** Transfer the measurement to complete an assigned task.
- E-77** Take accurate measurements with a micrometer.
- E-78** Select and use feeler gauges.

Communications

General Learning Objective: Given that a significant amount of the business machine repairer's operating time is devoted to the use of communication skills (reading, writing, speaking), the student will be able to demonstrate mastery of appropriate skills to specified standards.

- E-79** Give instructions for equipment operation.

- E-80** Follow specifications.
- E-81** Record inspection data.
- E-82** Plan work procedure using charts.
- E-83** Read and apply information in parts books, specification manuals, charts, blueprints, drawings, and diagrams.
- E-84** Write and/or print where required in a legible form.
- E-85** Sketch ideas to convey meaning to others. Read, sketch, and communicate mechanical concepts.
- E-86** Prepare requisitions for securing parts from a central storage area.
- E-87** Record incoming materials and supplies.
- E-88** Keep accurate time reports.
- E-89** Keep customer work records.
- E-90** Prepare a personal data sheet to present with the job application form.
- E-91** Compute basic practical math problems.

INTERMEDIATE-LEVEL JOB TITLE: BUSINESS MACHINE TECHNICIAN

At the intermediate level, the business machine technician performs many of the same tasks that are performed at the entry level except with greater proficiency, accuracy, and speed. Assignments at this level are varied to broaden training and experience and frequently involve following an operation through a series of related detailed steps or processes. The business machine technician is given more responsibility in planning work sequences and maintaining

quality control. The technician keeps his or her supervisor informed of work progress and consults the supervisor when unusual problems arise, when it is believed necessary to deviate from established procedures or practices, or when alternative methods need to be considered. In addition to having greater technical proficiency, the business machine technician is responsible for selected administrative duties and customer-related activities.

INTERMEDIATE-LEVEL TASKS

- I-1 Adjust operation of machines.
- I-2 Align machines with other machines or units in a system.
- I-3 Analyze data to diagnose cause of machine malfunction.
- I-4 Analyze test results.
- I-5 Clean parts using solvent.
- I-6 Compare operational performance with contract specifications.
- I-7 Compare readings to ascertain discrepancies.
- I-8 Compile testing data for quality-control purposes.
- I-9 Conduct acceptance or performance tests.
- I-10 Conduct specified tests.
- I-11 Connect controls of machines or system to control board.
- I-12 Connect product or part to test equipment.
- I-13 Demonstrate safety awareness and responsibility.
- I-14 Describe the primary functions and applications of common wires, cables, connectors, fuses and breakers, switches and relays, resistors, capacitors, inductors, transformers, diodes, vacuum tubes, semiconductors, sensors, and transducers.

- I-15 Determine priorities and sequences of work.
- I-16 Determine work procedures for performing repairs.
- I-17 Diagnose cause of malfunction or discrepancies.
- I-18 Disassemble or dismantle machine, component, or unit.
- I-19 Disassemble, replace or repair defective parts, and reassemble product.
- I-20 Draw freehand sketches of mechanical systems following conventional techniques.
- I-21 Estimate costs of mechanical maintenance and repair.
- I-22 Examine parts for defects.
- I-23 Identify and describe conventional types of drawings, schematics, diagrams, graphs and charts encountered in business machine repair.
- I-24 Identify and troubleshoot common electrical/electronic circuits including single and three-phase motors, motor controls, heating elements, fan, valve, switching, timing, etc., found in business machines.
- I-25 Identify conventional types of mechanical drawings and blueprints.
- I-26 Identify electrical/electronic components by physical characteristics, color codes, etc.
- I-27 Identify special techniques of soldering encountered in electro-mechanical systems.
- I-28 Identify standard types of specifications used in the electrical industry.
- I-29 Inspect machines, machinery, accessories, or units for need of repair.
- I-30 Inspect machines for ease and freedom of movement.
- I-31 Inspect machines for completeness and accuracy of assembly.
- I-32 Inspect machines for loose fittings and connections.
- I-33 Inspect machines for presence of foreign materials.
- I-34 Inspect machines for fit of interrelated parts.
- I-35 Inspect machines for wear of parts and need of replacement.
- I-36 Inspect machines for vibration stresses.
- I-37 Install large business machine circuits including correct wire size, circuit breaker, and receptacle in accordance with local codes.

- I-38 Install parts and set specified clearances between moving parts.
- I-39 Install, repair, service, and maintain machines.
- I-40 Know basic safety hazards and practices which exist in industry.
- I-41 Know safety rules that apply or may apply to local conditions.
- I-42 Know the safety practices and equipment to be used when the voltage exceeds 500 volts.
- I-43 Locate, read, and follow applicable provisions of local, state, and national electrical codes.
- I-44 Mark defects or defective areas on machines.
- I-45 Measure material parts or products specified for alignment of parts.
- I-46 Measure material parts or products specified for electrical characteristics.
- I-47 Measure parts for excessive wear.
- I-48 Move parts to insure ease and freedom of movement.
- I-49 Move parts to insure functional performance.
- I-50 Notify supervisory personnel of defects found and probable causes.
- I-51 Notify workers of corrections required to eliminate defects.
- I-52 Operate equipment to locate malfunctions.
- I-53 Order rework of installations having variance from specifications.
- I-54 Position and secure product or part in test fixture or equipment.
- I-55 Prepare itemized list of work and repairs required.
- I-56 Prepare rejection slips, repair orders, or salvage orders.
- I-57 Provide the name, value, type, rating, and symbol of any of a list of components.
- I-58 Read and interpret conventional drawings, diagrams, and charts used in electrical occupations.
- I-59 Read and interpret electrical/electronic and mechanical installation diagrams, schematics, blueprints, and manufacturers' manuals and literature.
- I-60 Read and interpret standard electrical terminology, abbreviations, and acronyms.

- I-61 Read and interpret standard mechanical drawings.
- I-62 Read and use standard symbols, line systems, notations, and terminology in mechanical drawings and blueprints.
- I-63 Read blueprints, schematic drawings, and technical manuals.
- I-64 Read dials and gauges to evaluate performance.
- I-65 Read gauges, indicators, and meters on test equipment.
- I-66 Readjust operation of machines as necessary to obtain efficient performance.
- I-67 Reassemble machine.
- I-68 Record number and type of defects on inspection record.
- I-69 Refer to charts or tables for specified test readings.
- I-70 Regrade machines according to quality and type of defect.
- I-71 Repair or replace defective part.
- I-72 Review product specifications.
- I-73 Review work orders to plan repair activities.
- I-74 Select the proper solder and fluxes for a given soldering task.
- I-75 Study blueprints, schematics, and circuit diagrams.
- I-76 Test materials, parts, or products for establishing quality control.
- I-77 Test product or part under simulated operational conditions.
- I-78 Use common handtools in the construction and modification of electro-mechanical systems.
- I-79 Use common handtools in the assembly-disassembly of electronic, electrical, and electro-mechanical equipment.
- I-80 Use proper first aid procedures.
- I-81 Use first aid equipment.
- I-82 Work safely using proper safety equipment and following established safety practices, procedures and standards.

ADVANCED-LEVEL JOB TITLE: BUSINESS MACHINE SERVICE MANAGER

The business machine service manager plans, schedules, and supervises all work done by the entry- and intermediate-level workers. The manager must have a thorough knowledge of business machine operation, repair, and maintenance; knowledge of the appropriate tools and testing equipment used; and a high level of technical expertise in establishing and maintaining quality-

control procedures. As an administrator and planner, the business machine service manager is responsible for controlling job costs, checking in-house record-keeping systems, and solving problems related to specific job orders. He or she also is responsible for personnel matters pertaining to the employment, on-the-job training, termination, and grievances of employees.

ADVANCED-LEVEL TASKS

Administrative Tasks

- A-1 Coordinate activities with other departments.
- A-2 Develop policies concerning worker seniority, performance reporting, and employee rating systems.
- A-3 Direct development of operating and maintenance manuals.
- A-4 Enforce administration policies, operating procedures, and safety rules.
- A-5 Enforce compliance of workers with established regulations, work procedures, and safety rules.
- A-6 Enforce compliance with established work procedures, regulations, and safety rules.
- A-7 Establish procedures for preparing and submitting reports.
- A-8 Formulate policy concerning wages and salary and worker requirements.
- A-9 Interpret policies, procedures, and regulations.
- A-10 Keep inspection and testing records.
- A-11 Keep maintenance and repair records.
- A-12 Plan and organize department practices and procedures.
- A-13 Prepare activity reports.
- A-14 Prepare operating and work schedules.

- A-15 Prepare reports on quality-control activities.
- A-16 Recommend changes in production procedures.
- A-17 Review progress and production charts and compliance reports.
- A-18 Review work orders to plan repair activities.

Fiscal Management Tasks

- A-19 Analyze and control expenditures.
- A-20 Analyze market and forecast trend reports.
- A-21 Contract for sale, purchase, and delivery of goods and services.
- A-22 Coordinate marketing and sales programs.
- A-23 Estimate cost of mechanical maintenance and repair.
- A-24 Investigate availability of equipment and approve cost estimates of equipment.
- A-25 Negotiate contracts.
- A-26 Prepare operations budget.
- A-27 Requisition inspection and testing materials, tools, and equipment.
- A-28 Requisition parts and materials.
- A-29 Resolve customer complaints.
- A-30 Review and revise budget allocations.

Supervisory Tasks

- A-31 Advise workers on methods and procedures for solving testing problems.
- A-32 Advise workers on methods and procedures for solving work problems.
- A-33 Appoint department heads.
- A-34 Assign workers to specific duties.
- A-35 Authorize promotions and transfers of personnel.
- A-36 Coordinate and revise production schedules.

- A-37** Coordinate quality-control activities with production activities.
- A-38** Coordinate repair and maintenance activity.
- A-39** Delegate functional activities and establish scope of responsibility.
- A-40** Determine priorities and sequences of work.
- A-41** Develop and execute plans for utilization of machines, workers, and material.
- A-42** Direct departmental operations.
- A-43** Evaluate workers and prepare performance reports.
- A-44** Give workers directions for performing duties.
- A-45** Initiate and recommend personnel action.
- A-46** Interpret work orders, specifications, drawings, and technical data to workers.
- A-47** Observe workers performing duties for compliance with work directions.
- A-48** Plan and determine worker requirements.
- A-49** Plan and determine worker schedules.
- A-50** Plan and direct production activities.
- A-51** Prepare work schedules and assign workers to duties.
- A-52** Recommend promotions, discharges, and disciplinary actions.
- A-53** Resolve worker complaints and grievances.
- A-54** Supervise and coordinate activities of workers engaged in inspecting mechanical machinery and equipment.
- A-55** Supervise and coordinate activities of workers engaged in diagnosing cause of malfunctioning machines and equipment.
- A-56** Supervise and coordinate activities of workers engaged in testing machines, machinery, or mechanical systems.
- A-57** Supervise and coordinate activities of workers engaged in maintaining machines and equipment in operable condition.
- A-58** Supervise and coordinate disassembling, repairing, and reassembling machines and equipment.

- A-59** Supervise and coordinate activities of workers engaged in adjusting and servicing mechanical machines, systems, and equipment.
- A-60** Supervise and coordinate activities of workers engaged in assembling and installing machines and equipment.
- A-61** Supervise and coordinate activities of workers engaged in installing components of machines.
- A-62** Supervise and coordinate activities of workers engaged in activities related to installing and connecting machines or machinery in systems.
- A-63** Supervise and coordinate activities of workers engaged in modifying and rebuilding machines and accessories.
- A-64** Supervise and coordinate activities of workers engaged in recording maintenance activities.
- A-65** Supervise and coordinate activities of workers engaged in recording test results.

Technical Tasks

- A-66** Analyze data to diagnose cause of machine malfunctions.
- A-67** Conduct field surveys of operational performance and recommend changes.
- A-68** Direct studies, investigations, and surveys.
- A-69** Inspect materials, products, or product parts for conformance with quality-control standards, assembly specifications, regulatory agency laws, directives, or codes.
- A-70** Inspect materials, products, or product parts for damage and identifying data.
- A-71** Inspect materials, products, or product parts for defects and faulty installation.
- A-72** Inspect materials, products, or product parts for quality and workmanship.
- A-73** Inspect work performed for compliance with specifications and time schedules.
- A-74** Interpret inspection and testing orders, product specifications, drawings, and technical data.
- A-75** Perform periodic checks on products and materials.
- A-76** Plan and determine inspection and testing procedures.
- A-77** Specify types and extent of tests on machines, machinery, or systems.

- A-78** Test materials, parts, or products for establishing quality-control standards and for mechanical characteristics.

Training Tasks

- A-79** Coordinate personnel and safety programs.
- A-80** Direct personnel and industrial training programs.
- A-81** Evaluate training programs and recommend changes.
- A-82** Plan and determine training requirements.
- A-83** Plan and implement safety programs.
- A-84** Train workers in inspection and testing duties.
- A-85** Train workers in operation of inspection and testing equipment.
- A-86** Train workers in repair and maintenance procedures.
- A-87** Train workers in safety practices and regulations.

SECTION 1.5

How to Develop Learning Activity Packages

The development of a performance-based curriculum for business machine repair training is based on a method called functional job analysis (described in Section 1.2). This method of analyzing actual job requirements as defined by employers is an effective way to develop a training curriculum. With this method, a training program curriculum can be created which contains the essential skills and knowledge that an entry-level worker performs on the job; and this can lead to the development of an instructional system that describes **what, why, and how** the trainee is to learn these skills and knowledge.

This section explains how to take the job tasks and learning objectives presented in Section 1.4 and develop units of instruction, or learning activity packages (LAPs), from them. Two sample LAPs—one based on a job task and one based on the mathematical skills of approximation and estimation—are included as models that can be used to develop LAPs at the local level.

In addition to the information and sample LAPs presented here, which are specifically related to the business machine repair training program, the instructor should refer to the series of POP (Pre-Service Occupational Program) Kits available from the Illinois Office of Education. The POP Kits cover such instructional planning topics as student performance objectives, domains of learning, writing sets of objectives, lesson planning, constructing learning activity packages, and instructional materials.

Section 1.5, when used in conjunction with the POP Kits, provides the tools for building an instructional system based on the job tasks, learning objectives, and supplementary materials presented in this guide.

PRINCIPLES OF LEARNING

No matter what the content of a curriculum or the instructional methods used, there are several basic principles of learning that underlie the development of learning activity packages. The two sample LAPs presented later in this section are guided by these principles; it is strongly recommended that the seven principles of learning described below be kept in mind as LAPs are developed for the training program.

Optimum Step Size. Optimum step size involves the application of two concepts. First, students learn best when they are not frustrated by material that is too difficult. Second, students learn best when they are challenged beyond boredom. To apply these concepts, instruction is developed by increments, or steps, that are small enough to permit mastery without frustration but are large enough to provide meaningful challenge. Determining the optimum step size depends on several factors such as student background, intelligence, difficulty of material, and so on.

Controlled Responding. Not only is the instruction presented to the student in predetermined steps, but it also directs him or her to assume an active role by performing specific activities within each step. These activities are determined during the development of the learning activity package. It requires each student to apply what he or she learns as it is learned. This insures that the student progresses toward the learning objective. When controlled responding is built into the learning, the student becomes an active, rather than passive, participant in the learning experience.

Knowledge of Results. After responding overtly to each optimum step of instruction, the student

learns whether the response was correct or incorrect. Such knowledge of results, also known as confirmation, serves two purposes. Its primary purpose is to reinforce the learning process. When a student responds correctly and is told so, the learning of correct performance is reinforced and he or she is motivated toward further learning. Its secondary purpose is to correct wrong responses and thus prevent the student from practicing wrong performances. Without such timely knowledge of results, a student can repeat a mistake until it becomes part of his or her performance.

Controlled Pacing. In conventional instruction the training time is usually a constant factor. For example, if it has been decided that a specified amount of time will be spent on a segment of learning, then all students receive the specified amount of time regardless of differences in aptitude. We know from experience, however, that students learn at varying rates; but little provision is ever made for this obvious fact. By using LAPs, on the other hand, instruction time becomes a variable instead of a constant factor. If student self-pacing can be built into the learning situation, each student is allowed to progress at his or her own rate according to learning ability. If self-pacing is working effectively, the faster student is not held back and the slower student is not forced to rush in order to keep up. Controlled pacing confirms the learning activity package as the method that most practically achieves a balance between the needs of teaching and the requirements of learning. If individually paced learning is not practicable, then a group-paced approach can be used. In this approach, students are organized into homogeneous pacing groups so that each group can proceed at the appropriate learning rate.

Validation. Validation is the process of determining the effectiveness of instruction. It places the burden of teaching upon the system; if the students fail to achieve the objective of the learning activity package, one should assume that the instruction has failed. When such failure occurs, the instruction should be revised and restructured until the students achieve the learning objective.

Student-Centered Approach. The student-centered approach is one that incorporates all the previous principles in a comprehensive learning system. The final outcome of instruction is focused on student performance and measuring that performance. Learning is student-centered when the student has been taught through optimum steps, has been directed to respond, has been provided with knowledge of results, has progressed at his or her own rate, or within a rate appropriate to a particular homogeneous group, and when a careful analysis of the student's performance has been conducted.

Performance Analysis. The final product of a performance analysis includes: a complete, precise listing of the skills and knowledge that must be taught in order to prepare the student to master the objective; a determination of the conditions under which the student will perform; and the factors which constitute acceptable performance by the student. Performance analysis consists of a review of all performance objectives, field surveys, task observations, and any other process which yields empirical data about the actual performance the student is expected to demonstrate at the conclusion of a learning activity package. The analysis should involve only those skills and knowledge that are critical to performance of the task or achieving the objective. It should omit any material that is "nice-to-know," but not critical.

LEARNING ACTIVITY PACKAGES

The successful learning activity package is based on the comprehension, by the instructor and the student, of these four terms: objective, overview, learning experience, and summary.

The objective is the end result toward which student effort is directed in the package. It is stated in performance terms, which means that the student must demonstrate achievement of the performance specified. The objective states what the student should have learned at the completion of the LAP. The overview explains why it is important to achieve the stated objective and how it can benefit the student. The

learning experience guides the student through a step-by-step process to achieve the objective. The **summary** reviews the reason for doing the particular activity and reinforces the learning that has occurred during the LAP.

The key point of a learning activity package is, of course, the LAP's objective. The objective determines both the content and the activities of the LAP. The other components of the LAP, particularly the learning experiences, should support and satisfy the learning objective. Upon completion of the activities prescribed by the learning experiences, the student should be able to demonstrate the capability stated in the objective.

The learning experiences within the LAP should reflect the student capabilities necessary to satisfy the LAP's objective. The number of experiences and their content may vary from LAP to LAP. In fact, a given capability can, and should, be attained through different kinds of learning experiences. The instructor should be able to use various types of instructional methods (see Section 1.6) in order to provide students with appropriate learning experiences that will lead to mastery of the LAP objective.

In order to provide the student with first-hand exposure to vocational capabilities, emphasis must be placed on performance-based learning experiences—i.e., LAPs based on the tasks presented in Section 1.4. Performance-based activities permit the student to utilize both cognitive and psychomotor processes in achieving the objectives of a learning activity package. They also provide the instructor and student with the opportunity to evaluate the attainment of vocational capabilities.

Non-performance activities, to be sure, have their value; but these activities alone cannot provide the student with the capabilities which he or she will need on the job in the working world. In addition, many students are at relatively low reading and vocabulary levels; this casts doubt on how much the student really learns through these methods. There is also a question if portions of theories, principles, or concepts are

really needed by the student to achieve given capabilities at a particular level or if they are needed at all. Determining how much theory and how much practice is to be included in a learning activity package is sometimes a difficult process. Very often, however, a clear statement of the LAP's objective will provide the answer.

Another factor to be considered in developing LAPs involves the selection of appropriate reference materials and teaching-learning aids. This requires a consideration of a number of factors, such as the relevance of the information, the ability of the student to benefit from it, and its availability, cost, and ease of use. These must be evaluated continually since the criteria for their selection may change from LAP to LAP. Section 1.7 lists references and resources for a variety of business machines which the instructor should find useful in developing learning activity packages.

DEVELOPING LAPs FROM A TASK

In Section 1.1 of the guide you followed a series of steps in order to specify the content of the training program. The result of this process was a sequenced list of performance-based tasks and their associated learning objectives. The steps below show one way to identify the skills, knowledge, and activities related to each task that can be used to develop one or more learning activity packages.

To help you work through these steps, three worksheets are provided on the following pages. (Blank worksheets are provided at the end of this section for duplication and use by the instructor.) Steps 1-6 explain Worksheets 1 and 2 and help you to gather and organize the information needed to develop a LAP. Worksheet 1, "Task Listing," involves selecting a task for instruction and identifying tasks that are related to the selected task. Worksheet 2, "Task Analysis," is used for breaking down a task into the skills and knowledges required to perform the task. Steps 7-11 explain Worksheet 3, "LAP Outline," which is used for organizing the information developed on Worksheets 1 and 2 into a learning activity package outline.

STEP 1: Select a task for instruction.

From your list of sequenced tasks, select one task for instruction. Write this task down in the space provided on Worksheet 1. For the sample LAP presented in this section, the following task was selected: "Disassemble and reassemble equipment."

STEP 2: Identify tasks that are closely related to the task selected in Step 1.

Although you are working with only one task at a time, it is important to identify those tasks that are closely related to the task you selected. By completing this step, you will establish interrelationships among a group of tasks. Write down these tasks in the spaces provided on Worksheet 1. Examine these tasks and how they are related to one another. This helps to establish a sequence for other learning activity packages that you will develop.

STEP 3: Specify the learning conditions and outcomes of the task to be performed by the student.

Moving on to Worksheet 2, write down the task, the learning conditions under which the task will be performed by the student, and the outcomes which will be used to evaluate student performance. For the sample LAP, the learning conditions are: "Business machine, technical diagram, printed disassembly procedures, and tools." The outcome by which student performance will be judged is: "Correct disassembly of equipment under supervision."

STEP 4: Break down the task into learning activities.

The task you have selected should now be broken down into more manageable components—learning activities. Because the task is stated in

broad, generic terms, it is at this point that the type of machine to be disassembled and reassembled should be specified. On Worksheet 2 in the space labeled "Learning Activity" has been entered: "Disassemble a Royal Standard Typewriter Model M.C." Additional learning activities can be generated in a similar way for other specific types of business machines. (Reassembly procedures for each machine would entail a separate category of learning activities.)

STEP 5: Break down each learning activity into specific steps.

On Worksheet 2 the sample learning activity has been broken down into a series of steps. For each of the other learning activities involving the disassembly of machines a similar sequenced list of operational steps would be generated on Worksheet 2.

STEP 6: Identify the knowledges which support the performance of each activity.

The final component of Worksheet 2 is a listing of the knowledges which support the performance of the steps under each activity. For example, in disassembling a business machine it is essential for the business machine repairer to be able to read and understand technical diagrams and to know the use of disassembly tools. The supporting knowledges are listed below the series of steps for the sample activity identified on Worksheet 2.

Steps 1-6 above have helped you to gather and organize the information needed for the development of LAPs related to a single task statement: "Disassemble and reassemble equipment." All of this information has been entered on Worksheets 1 and 2. Steps 7-11 explain how to take the information from Worksheets 1 and 2 and develop an outline for a single learning activity package.

STEP 7: Select one learning activity from Worksheet 2 as the content for a single LAP.

In the sample provided in this section, the learning activity "Disassemble a Royal Standard Typewriter Model M.C." has been selected as the content for a learning activity package. The other learning activities identified for other types of equipment can be used for the development of subsequent LAPs. The intent of selecting just one learning activity is to narrow the focus of the selected task and resultant instruction to one type of business machine. Enter the activity name and the steps into which it has been broken down in the spaces provided on Worksheet 3.

STEP 8: Write the objective for the LAP.

On Worksheet 2 the learning conditions and the performance outcome were identified for the task statement as a whole. Using this information as a foundation, write the LAP objective as it pertains to the specific learning activity you selected. It is important to remember that any learning objective is made up of these two parts—the learning conditions and the performance outcome. The objective is a statement of what the student will be able to do at the completion of the LAP. On Worksheet 3 the objective of the sample LAP has been stated as: "Given a Royal Standard Typewriter Model M.C., technical diagram, printed disassembly procedures, and tools, the student will be able to correctly disassemble the typewriter under supervision."

STEP 9: Write an overview to the LAP.

The overview provides a general introduction to the LAP, explains the importance of the LAP's objective, and how it can benefit the student. It also serves as a link to other kinds of tasks that have already been taught or will be taught in subsequent LAPs (see Worksheet 1). Writing the overview is an important step in LAP development, because it requires the instructor to focus his or her attention on what is to be learned during this particular LAP. Review the sample overview on Worksheet 3 to see how this is accomplished.

STEP 10: List learning experiences for the LAP.

Learning experiences should take into account all of the steps listed at the top of Worksheet 3. In preparing a LAP outline, list the learning experiences that are needed to deal with each step and that will accomplish the objective. For the sample unit these are listed in the space provided under "Learning Experiences."

STEP 11: Write a summary of the LAP.

The summary provides a review of the outcome of the learning experiences in order to reinforce the learning that has taken place during the LAP. Space is provided on Worksheet 3 to write this summary.

Worksheet 1

TASK LISTING

Job: Business Machine Repairer

Task: Disassemble and reassemble equipment.

Related Tasks:

1. Remove and replace equipment components.
2. Select and use hand and power tools to perform maintenance tasks.
3. Troubleshoot mechanical equipment operation.
4. Remove, examine, and install bearings.
5. Lubricate office machines.
6. Remove, replace, align, and check tolerances of couplings and clutches.
7. Remove and replace pulleys and sprockets.
8. Assemble gear patterns following technical diagrams.
9. Inspect gears for defects.
10.

Worksheet 2
TASK ANALYSIS

Job:	<u>Business Machine Repairer</u>
Task:	<u>Disassemble and reassemble equipment.</u>
Learning Conditions:	<u>Business machine, technical diagram, printed disassembly procedures, and tools.</u>
Outcome:	<u>Correct disassembly of equipment under supervision.</u>

Learning Activity: Disassemble a Royal Standard Typewriter Model M.C.

- Steps:**
1. Facing front of machine move carriage to extreme right margin, grasp top cover (1) in center, push rearward and lift up.
 2. Remove bichrome selector lever screw (22) and remove lever (4).
 3. Loosen two screws (3) as far as possible.
 4. Remove screw (7) and slide back cover left (5) off.
 5. Remove screw (10) and slide back cover right (8) off.

Worksheet 2 – Continued

TASK ANALYSIS

6. Remove two screws (14), loosen two screws (15), slide top cover rear (13) off machine frame.

7. Remove two screws (17) left and right and remove segment dust covers (16) left and right.

8. Place machine on its back very carefully.

9. Remove four screws (19 and 20), remove rubber feet front and rear.

10. Place machine on its feet and lift machine from base cover (18).

11. Loosen two screws and raise paper table (1) and remove two retaining rings (2), slide tie rod (3) to the right to clear extension (4), slide tie rod left to clear right extension (5).

12. Loosen left variable knob screws and remove left knob from shaft.

13. Remove two screws (7), depress left rack release lever, and remove carriage end cover left (8).

Worksheet 2 – Continued
TASK ANALYSIS

14. Remove screw (9), lift paper holder assembly and remove carriage end cover inside left.

15. Place right hand on right platen knob, pull platen release lever forward and remove platen from machine.

16. Loosen screw (11), remove nut (12), maneuver the carriage end cover right (10) off machine.

17. Remove screw (14) (inside carriage end), raise paper holder assembly, remove carriage end cover inside right (13).

18.

19.

20.

Supporting Knowledge Required: Read and understand technical diagrams and the use of disassembly tools.

Worksheet 3

LEARNING ACTIVITY PACKAGE OUTLINE

Job: Business Machine Repairer

Task: Disassemble and reassemble equipment.

Learning Activity: Disassemble a Royal Standard Typewriter Model M.C.

- Steps:
1. Facing front of machine move carriage to extreme right margin, grasp top cover (1) in center, push rearward and lift up.
 2. Remove bichrome selector lever screw (22) and remove lever (4).
 3. Loosen two screws (3) as far as possible.
 4. Remove screw (7) and slide back cover left (5) off.
 5. Remove screw (10) and slide back cover right (8) off.
 6. Remove two screws (14), loosen two screws (15), slide top cover rear (13) off machine frame.

LEARNING ACTIVITY PACKAGE OUTLINE

7. Remove two screws (17) left and right and remove segment dust covers (16) left and right.

8. Place machine on its back very carefully.

9. Remove four screws (19 and 20), remove rubber feet front and rear.

10. Place machine on its feet and lift machine from base cover (18).

11. Loosen two screws and raise paper table (1) and remove two retaining rings (2), slide tie rod (3) to the right to clear extension (4), slide tie rod left to clear right extension (5).

12. Loosen left variable knob screws and remove left knob from shaft.

13. Remove two screws (7), depress left rack release lever, and remove carriage end cover left (8).

14. Remove screw (9), lift paper holder assembly and remove carriage end cover inside left.

LEARNING ACTIVITY PACKAGE OUTLINE

15. Place right hand on right platen knob, pull platen release lever forward and remove platen from machine.

16. Loosen screw (11), remove nut (12), maneuver the carriage end cover right (10) off machine.

17. Remove screw (14) (inside carriage end), raise paper holder assembly, remove carriage end cover inside right (13).

18.

19.

20.

Supporting Knowledge Required: Read and understand technical diagrams and the use of disassembly tools.

Worksheet 3 – Continued

LEARNING ACTIVITY PACKAGE OUTLINE

LAP Objective: Given a Royal Standard Typewriter Model M.C., technical diagram, printed disassembly procedures, and tools, the student will be able to correctly disassemble the typewriter under supervision.

Overview: A large portion of the business machine repairer's time is spent on disassembly and assembly or removing and replacing individual parts or components of business equipment. It is important, therefore, for the student to have a firm grounding and practical experience in reading technical diagrams, following prescribed disassembly procedures, and using appropriate tools. This learning activity package focuses on one particular type of business machine, the Royal Standard Typewriter Model M.C. These generic skills can be applied to other types and models of business machines.

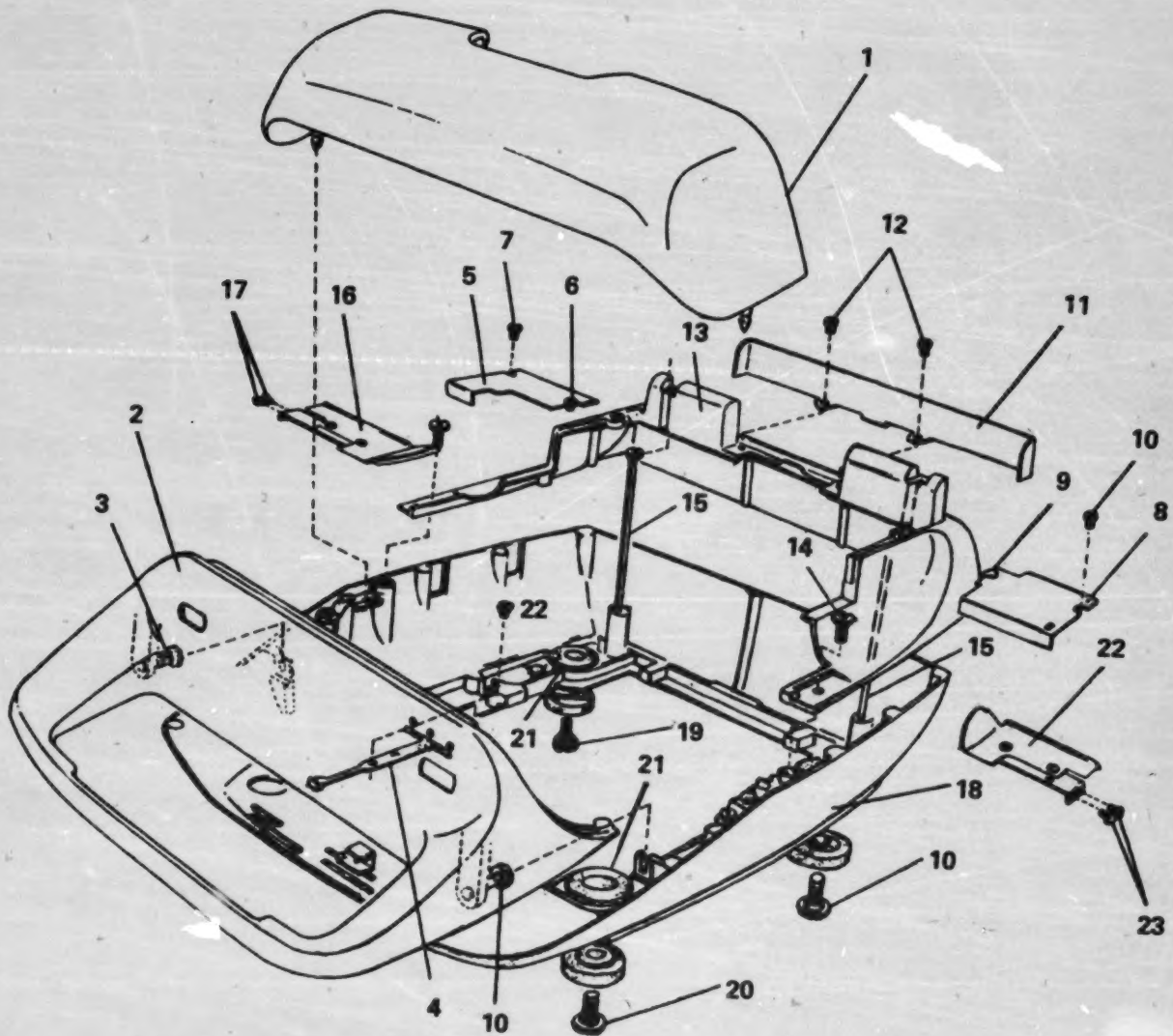
Learning Experiences:

1. Student-instructor conference to set up practice exercise.
2. Slide/tape presentation on disassembly procedures.
3. Background readings in Royal Standard Typewriter Model M.C. training manual.
4. Other teaching-learning approaches deemed appropriate by the instructor.
5. _____

LEARNING ACTIVITY PACKAGE OUTLINE

Summary: By successfully completing this learning activity package, the student has gained two kinds of experience: (1) disassembly procedures for one specific type of business machine, the Royal Standard Typewriter Model M.C., and more generally (2) technical diagram reading, following prescribed disassembly procedures, and the use of appropriate tools. The skills learned during this LAP are basic performances that can be applied to other types and models of business machines.

DIAGRAM 1



EVALUATING STUDENT PERFORMANCE

On the next page is offered one method for evaluating student performance on the LAP described above. The Student Evaluation Checklist is based on observing the performance of the student for each step of the learning activity. The learning activity can be designated as one that requires limited skill (L), moderate skill (M), or proficiency (P). As the student performs each step in the LAP, the instructor can rate the student's performance as either satisfactory (S)

or unsatisfactory (U). This is an easy way to keep track of each student's performance on LAPs presented over a period of time. It also offers the instructor a means of determining which skills have been mastered and which skills have not been mastered by the student group as a whole. By reviewing these checklists periodically, the instructor can pinpoint the areas of instruction in which students need additional help. (A blank Student Evaluation Checklist is provided at the end of this section for duplication and use by the instructor.)

STUDENT EVALUATION CHECKLIST

Key: L = Limited skill
M = Moderate skill
P = Proficiency

S = Satisfactory
U = Unsatisfactory

Student Name: _____

Date: _____

Instructor: _____

RATING

CRITERIA

L M P Learning Activity: Disassemble a Royal Standard Typewriter Model M.C.

S U Steps: 1. Facing front of machine move carriage to extreme right margin, grasp top cover (1) in center, push rearward and lift up.

S U 2. Remove bichrome selector lever screw (22) and remove lever (4).

S U 3. Loosen two screws (3) as far as possible.

S U 4. Remove screw (7) and slide back cover left (5) off.

S U 5. Remove screw (10) and slide back cover right (8) off.

STUDENT EVALUATION CHECKLIST - Continued

- S U 6. Remove two screws (14), loosen two screws (15), slide top cover rear (13) off machine frame.
- S U 7. Remove two screws (17) left and right and remove segment dust covers (16) left and right.
- S U 8. Place machine on its back very carefully.
- S U 9. Remove four screws (19 and 20), remove rubber feet front and rear.
- S U 10. Place machine on its feet and lift machine from base cover (18).
- S U 11. Loosen two screws and raise paper table (1) and remove two retaining rings (2), slide tie rod (3) right to clear extension (4), slide tie rod left to clear right extension (5).
- S U 12. Loosen left variable knob screws and remove left knob from shaft.
- S U 13. Remove two screws (7), depress left rack release lever, and remove carriage end cover left (8).

STUDENT EVALUATION CHECKLIST — Continued

- S U 14. Remove screw (9), lift paper holder assembly and remove carriage end cover inside left.
- S U 15. Place right hand on right platen knob, pull platen release lever forward and remove platen from machine.
- S U 16. Loosen screw (11), remove nut (12), maneuver the carriage end cover right (10) off machine.
- S U 17. Remove screw (14) (inside carriage end), raise paper holder assembly, remove carriage end cover inside right (13).
- S U 18. _____
- S U 19. _____
- S U 20. _____

DEVELOPING LAPS FROM A GENERAL KNOWLEDGE CONCEPT

On the following pages is a sample LAP based on the general knowledge concept of "approx-

mation and estimation." Again, the LAP's four components—objective, overview, learning experiences, and summary—are presented in detail. This LAP is one that students work through on their own with a minimum of interaction with the instructor.

**(SAMPLE LEARNING ACTIVITY PACKAGE
BASED ON A GENERAL KNOWLEDGE CONCEPT)**

**LEARNING ACTIVITY PACKAGE 1:
APPROXIMATION AND ESTIMATION**

OBJECTIVES

When you have completed this unit, you will be correct 85% of the time when you:

1. identify whether numbers in a list are exact or approximate.
2. list reasons why a number is approximate.
3. identify the maximum error, as a tolerance, of measurements you have made.
4. rewrite a list of measurements so that they all are of the same precision.
5. measure an object to a certain degree of precision (tolerance).
6. state the relative error and degree of accuracy of a measurement.
7. round off measurements and numbers to a specified place.
8. estimate a sum, difference, product or quotient to within 10% of the actual value.

OVERVIEW

It is impossible to exactly measure anything. There is always some amount of error in any measurement you make. In everyday life when you make measurements it is often necessary to tell how much in error your measurement is. In this learning activity you will learn about different types of errors and how to let other people know about them when they appear in your work. (The prerequisites for this LAP are satisfactory completion of the LAPs on Base 10, Number Line, Whole Numbers, Fractions, Decimals, Reciprocals, Measurement, Metric System, Averages, Percent, Ratio and Proportion, Square Roots, and Laws of Indices.)

DIAGNOSTIC PRETEST

1. Which of the following are approximate measures? Circle the letter appearing before the measure if it is approximate.

- a. Baseball score: Pittsburgh 3, Chicago 2
- b. Enrollment of Plainview High School: 478 pupils
- c. Springfield area rainfall for 1967: 24.3 inches
- d. World's record for the 100-yard dash: 9.1 seconds
- e. Automobiles manufactured during the month of August at the Dearborn plant: 1,463

2. For each approximate measure in Question 1, write two reasons why it is an approximate measure and not an exact measure.

3. Write the maximum error, as a tolerance, for the following measurement:

249.10 inches

maximum error = _____

4. Rewrite the following measurements so that they are all of the same precision as the example:

Example: $4\frac{3}{4}$ inches

a. $6\frac{12}{16}$ inches = _____

b. 2.500 inches = _____

c. 3.000 inches = _____

d. $5\frac{2}{8}$ inches = _____

5. Measure the diameter of a 25-cent piece to the nearest $\frac{1}{16}$ inch:

6. State the relative error, correct to two decimal places, for the measurement made in Question 5:

7. State the degree of accuracy, to the nearest whole percent, of the measurement made in Question 5:

8. Round off these numerals to the stated number of decimal places:

	Numeral	Places	Rounded-Off Numeral
a.	14.145	1	_____
b.	69.937	0	_____
c.	2410.005	2	_____
d.	3.14159	4	_____

9. Estimate the product of 710 and 45:

Check your answers with the teacher.

LEARNING EXPERIENCES

As you work through the learning experiences, check your answers in the answer section at the back of this package. If you do not understand any of the questions or the answers, ask your teacher for help.

1. Choose a partner to work with you on these questions.
2. Each of you take a separate sheet of paper and independently (this means you should not show one another the piece of paper or talk over what you are doing until you are told to do so):
 - a. with a yardstick, measure to the nearest $\frac{1}{16}$ " the length of the same window pane in your classroom.
 - b. with a yardstick, measure to the nearest $\frac{1}{16}$ " the width of the same window pane in your classroom.
 - c. with a yardstick, measure to the nearest $\frac{1}{16}$ " the height of the same supply cabinet in your classroom.
 - d. count the number of students present in your classroom today.
 - e. count the number of desk chairs that are in your classroom.

Write each measurement or count on your piece of paper.

3. After both of you have measured and counted EVERYTHING in Question 2, compare your lists. Circle two of the five things you did which agree most completely on the two lists:
a, b, c, d, e.
4. List all the reasons you can think of why the other three measurements did not agree completely between the two lists.

5. Make each statement true by crossing out the wrong word.
- Exact/approximate numbers are the result of measurements.
 - Exact/approximate numbers are the result of counting.
6. Which of the following are exact or counted measures and which are approximate? Circle the correct choice.
- | | |
|---------------------------------------|--------------------|
| a. baseball score | exact, approximate |
| b. enrollment of your school | exact, approximate |
| c. annual rainfall in Pennsylvania | exact, approximate |
| d. time to run 50 yards | exact, approximate |
| e. tickets sold for the football game | exact, approximate |
| f. tractors manufactured in May | exact, approximate |
7. Which sources of error from the following list could account for one of the measures in Question 6 being approximate? Write the letter of the measurement from Question 6 after the source of error.
- poor eyesight _____
 - lack of skill _____
 - lack of experience _____
 - haste _____
 - expecting a certain value _____
 - temperature _____
 - weather conditions _____
 - vibration _____
 - jarring of measuring instrument _____
 - unexpected strain on measuring instrument _____
 - bad design of measuring instrument _____
 - careless calibration of measuring instrument _____
 - zero error—instrument does not read zero when not measuring anything _____
 - matching the position of the ends of a measuring stick when the length to be measured is longer than the size of the stick _____
 - parallax-eye, instrument scale, and object are not properly aligned _____

8. Write a brief definition of what you think "precision" is when it pertains to measurement.

Write a brief definition of what you think "accuracy" is when it pertains to measurement.

Precision

Rule: "The smaller the unit of measurement, the more precise the measurement."

9. Circle the most precise measurement in each series.

- a. 1" 1' 1 yd.
- b. 1" 10" $\frac{1}{2}$ " 1'
- c. $\frac{1}{2}$ " $\frac{2}{4}$ " $\frac{4}{8}$ "
- d. $5\frac{13}{16}$ " $5\frac{6}{8}$ " $3\frac{2}{4}$ " 7"

10. Rewrite the measurements in Question 9, part d, so that they are all of the same degree of precision. (Hint: 7" may be written as $7\frac{0}{16}$ ".)

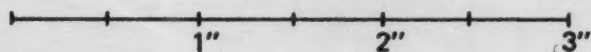
Maximum Error

11. Precision may also be indicated as a TOLERANCE, or by stating the MAXIMUM ERROR of a measurement.

Both maximum error and tolerance depend on the smallest unit or mark that is on the scale of your measuring instrument.

- a. What is the smallest unit of measure on Scale M? _____

Scale M:



Using Scale M, measure the length of each of the following line segments:

X _____
Y _____
Z _____

b. X = _____

c. Y = _____

d. Z = _____

12. If line segment X were $\frac{1}{8}$ " shorter, how long would it be compared to Scale M?

13. If line segment Z were $\frac{1}{8}$ " longer, how long would it be compared to Scale M?

14. A line segment that is $1\frac{1}{2}$ " long would include all line segments from 1 — to 1 — on Scale M.

15. A line segment $1\frac{1}{2}$ " long could be at most _____ inches shorter or longer than $1\frac{1}{2}$ " on Scale M.

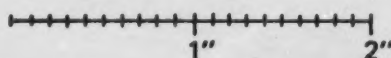
16. This length from Question 15, or one-half the smallest unit or place value of the measurement, is the MAXIMUM ERROR of the unit.

What is the maximum error of:

$1\frac{1}{2}$ " _____

1.5" _____

17. When you find the maximum error of measurements expressed as decimals you must take one-half of the smallest place value. Thus the maximum error of 1.5" is NOT .25". It is .05", as shown below:



Scale is divided into $\frac{1}{10}$ " units.

18. Fill in the blanks:

	Smallest unit or place value	Maximum error
a. $1\frac{1}{4}$ inches	_____	_____
b. 1.3 inches	_____	_____
c. $9\frac{5}{8}$ inches	_____	_____
d. 12.68 feet	_____	_____
e. $4\frac{0}{16}$ inches	_____	_____
f. 3 hours 13 minutes	_____	_____

Tolerance

19. Tolerance is a way of expressing the maximum error along with the measurement.

The maximum error of $\frac{1}{4}$ " of a measurement of $1\frac{1}{2}$ " is expressed in tolerance form:

$$1\frac{1}{2} \pm \frac{1}{4}"$$

60

20. Rewrite the measurements in Question 18 with their maximum error expressed in tolerance form.
- | | |
|----------|----------|
| a. _____ | d. _____ |
| b. _____ | e. _____ |
| c. _____ | f. _____ |
21. Suppose you measured a line to the nearest $\frac{1}{4}$ " and found the measurement closer to 5" than to $4\frac{3}{4}$ " or $5\frac{1}{4}$ ".

Why would you record the measurement as $5\frac{0}{4}$ " instead of 5"?

Accuracy

22. Take a piece of cardboard which is 3" long and mark one edge off into half inches. Using this new rule, measure the following to the nearest half inch:
- | | |
|--|--------|
| a. the diameter of your pencil | _____" |
| b. the width of the arm of your desk chair | _____" |
| c. the height of the blackboard | _____" |
23. What is the maximum error of each measurement? _____
24. Are all the measurements in Question 22 equally precise? _____
25. In Question 22, there is one measurement where the maximum error is more important for accuracy. Which is it: a, b, or c? (Circle one.)
26. The diameter of the pencil is small compared to the maximum error of the instrument. This means that we will not get an accurate measurement of the diameter no matter how often we measure it.

27. As the size of the object we measured increased, the size of the maximum error became less important. We use the term "relative error" to describe how important this relationship is.

The formula for relative error is:

$$\text{Relative Error} = \frac{\text{Maximum Error}}{\text{Recorded Measurement}}$$

28. Calculate the relative error for b and c of Question 22.

relative error for b _____

relative error for c _____

29. Explain in your own words what the term "relative error" means.

30. In Question 28, which relative error is larger: b or c ? (Circle one.)

31. Based on the size of relative errors, which measurement in Question 28 was more accurate: b or c ? (Circle one.)

32. The size of a relative error indicates how accurate your measurement was. Make this sentence true by circling the correct word.

"One measurement is more accurate than another if it has a larger / smaller relative error."

33. Look at the formula for relative error in Question 27. In order for you to reduce the relative error, it is necessary for you to change only one of the other two components of the formula. Which one would you change and how would you change it (make it larger, smaller, etc.)?

34. A "degree of accuracy" may be found by changing the relative error into a percent, and then subtracting this from 100. An acceptable degree of accuracy for most measurements is 95%.

Convert the relative errors in Question 28 into degrees of accuracy.

degree of accuracy for b _____

degree of accuracy for c _____

Rounding Off

35. To avoid all confusion when rounding off numbers, use this rule: "If the left-most digit of the part of the number to be dropped is a 0, 1, 2, 3 or 4, drop this whole part of the number."

Example: Round off 6.149 to one decimal place. Answer: 6.1

Round off these numbers to one decimal place:

- a. 6.103 _____
- b. 6.113 _____
- c. 6.123 _____
- d. 6.133 _____
- e. 6.143 _____

36. Another rule to follow when rounding off numbers is: "If the left-most digit of the part of the number to be dropped is a 5, 6, 7, 8 or 9, drop this whole part of the number and add one (1) to the final digit retained."

Example: Round off 6.159 to one decimal place. Answer: 6.2

Round off these numbers to three decimal places:

- a. 6.28509 _____
- b. 6.28519 _____
- c. 6.28529 _____
- d. 6.28539 _____

- e. 6.28549 _____
- f. 6.28559 _____
- g. 6.28569 _____
- h. 6.28579 _____
- i. 6.28589 _____
- j. 6.28599 _____

Estimation

37. Accurate estimation requires the ability to round off numbers correctly. Estimation also implies that you are going to add, subtract, multiply or divide numbers. All of the following estimations can be made using the same technique:

"Estimate the sum of 1981 and 344."

"Estimate the difference of 1981 and 344."

"Estimate the product of 1981 and 344."

"Estimate the quotient of 1981 divided by 344."

38. Estimate the following answers:

- a. The sum of 2000 and 300 is _____
- b. The difference of 2000 minus 300 is _____
- c. The product of 2000 and 300 is _____
- d. The quotient of 2000 divided by 300 is _____

39. What change was made to the numbers used in Question 37 that resulted in the numbers used in Question 38?

40. Every time you round off numbers that you have to add, subtract, multiply or divide so that you are working with round numbers that consist of a single, non-zero digit and zeros, you should be accurate to within 10% of the actual answer.

List three situations where you could apply this principle:

- a. _____
- b. _____
- c. _____

CRITERION POSTTEST

1. Circle the letter appearing before the measure if it is an approximate measure:
 - a. Football score: Kansas City 29, St. Louis 6
 - b. Enrollment of Baylor Junior High School: 682 pupils
 - c. Rockford area snowfall for 1966: 18.0 inches
 - d. World's record for the mile: 3 minutes 51 seconds
 - e. Trawlers manufactured during the month of September at the Quincy shipyards: 6
2. For each approximate measure in Question 1, write at least two reasons why it is an approximate measure and not an exact measure.

3. Write the maximum error, as a tolerance, for the following measurement:

8.63 seconds maximum error = _____

4. Rewrite the following measurements so that they are all of the same precision as the example:

Example: 2.20 seconds

- a. $6\frac{1}{5}$ seconds = _____
- b. 4.859 seconds = _____
- c. $9\frac{0}{5}$ seconds = _____
- d. 1.1 seconds = _____

5. Measure the diameter of a 5-cent piece to the nearest $\frac{1}{16}$ inch:

6. State the relative error, correct to two decimal places, for the measurement made in Question 5:

7. State the degree of accuracy, to the nearest whole percent, for the measurement made in Question 5:

8. Round off these numerals to the stated number of decimal places:

	Numeral	Places	Rounded-Off Numeral
a.	8.1818	3	_____
b.	4.067	0	_____
c.	3.333	1	_____
d.	1.2121	2	_____

9. Estimate the quotient of 39,673 divided by 54:

Check your answers with the teacher.

SUMMARY

In this unit you have learned something about types of errors that appear in measurements, some that you would like to reduce or eliminate, and others that you want to make on purpose such as in rounding off or in estimating. Whenever you must add, subtract, multiply, or divide measurements you may increase your errors unless you know what to do and exactly when to round off.

REFERENCES

1. Glenn, W. H., & Johnson, D. A. Invitation to mathematics. Garden City, N.Y.: Doubleday,
2. Larsen, H. D., & Ludlow, H. G. Arithmetic for colleges. New York: Macmillan, 1963.
3. Rassweiler, M., & Harris, J. M. Mathematics and measurements. Dubuque, Ia.: Wm. C. Brown Book Co., 1962.

ANSWER KEY FOR QUESTIONS 1-40

1. No answer.
2. Varies with the size of the objects.
3. d, e
4. Different for each student—accept, if logical.
5. a. approximate
b. exact
6. a. exact
b. exact
c. approximate
d. approximate
e. exact
f. exact
7. c and d should appear after all except n.
8. Different for each student.
9. a. 1"
b. $\frac{1}{2}$ "
c. $\frac{4}{8}$ "
d. $5\frac{13}{16}$ "
10. $5\frac{13}{16}$ " $5\frac{12}{16}$ " $3\frac{8}{16}$ " $7\frac{0}{16}$ "

11. a. $\frac{1}{2}$ "

b. $1\frac{1}{2}$ "

c. $1\frac{1}{2}$ "

d. $1\frac{1}{2}$ "

12. 1"

13. 2"

14. $\frac{1}{4}$ " $\frac{3}{4}$ "

15. $\frac{1}{4}$ "

16. $\frac{1}{4}$ " .05"

17. No answer.

18. a. $\frac{1}{4}$ " $\frac{1}{8}$ "

b. .1" .05"

c. $\frac{1}{8}$ " $\frac{1}{16}$ "

d. .01' .005'

e. $\frac{1}{16}$ ' $\frac{1}{32}$ "

f. 1 minute 30 seconds, or .5 minutes

19. No answer.
20. a. $1\frac{1}{4} \pm \frac{1}{8}$ " d. $12.68 \pm .005'$
b. $1.3 \pm .05$ " e. $4\frac{0}{16} \pm \frac{1}{32}$ "
c. $9\frac{5}{8} \pm \frac{1}{16}$ " f. 3 hours 13 minutes $\pm$ 30 seconds
21. $5\frac{0}{4}$ " shows that the measurement was made to the precision of $\frac{1}{4}$ ", which is correct. 5" implies the measurement was made to a precision of 1", which is incorrect.
22. Varies with the size of the objects.
23. $\frac{1}{4}$ "
24. Yes
25. a
26. No answer.
27. No answer.
28. Varies with the size of the object.
29. Different for each student. Could be "Relative error describes the relationship (or compares the sizes) of the maximum error of a measurement and the measurement itself."
30. b

31. c
32. Smaller
33. Maximum error—make it smaller by measuring to a greater precision.
34. Varies with the size of the object.
35. a. 6.1 d. 6.1
b. 6.1 e. 6.1
c. 6.1
36. a. 6.285 f. 6.286
b. 6.285 g. 6.286
c. 6.285 h. 6.286
d. 6.285 i. 6.286
e. 6.285 j. 6.286
37. No answer.
38. a. 2300 b. 1700 c. 600,000 d. 6 (approximately)
39. They were rounded off to one digit. The digits dropped were replaced by zeros.
40. Different for each student.

WORKSHEETS

On the following pages are blank worksheets and a student evaluation form which can be duplicated and used for developing learning activity packages for your business machine repair training program.

Worksheet 1
TASK LISTING

Job: _____

Task: _____

Related Tasks:

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

Worksheet 2
TASK ANALYSIS

Job:	_____
Task:	_____ _____
Learning Conditions:	_____ _____
Outcome:	_____

Learning Activity: _____

- Steps: 1. _____

2. _____

3. _____

4. _____

5. _____

Worksheet 2 – Continued
TASK ANALYSIS

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

13. _____

Worksheet 2 – Continued
TASK ANALYSIS

14. _____

15. _____

16. _____

17. _____

18. _____

19. _____

20. _____

Supporting Knowledge Required: _____

Worksheet 3

LEARNING ACTIVITY PACKAGE OUTLINE

Job: _____

Task: _____

Learning Activity: _____

Steps: 1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

Worksheet 3 – Continued

LEARNING ACTIVITY PACKAGE OUTLINE

7.

8.

9.

10.

11.

12.

13.

14.

LEARNING ACTIVITY PACKAGE OUTLINE

15. _____

16. _____

17. _____

18. _____

19. _____

20. _____

Supporting Knowledge Required: _____

Worksheet 3 – Continued

LEARNING ACTIVITY PACKAGE OUTLINE

LAP Objective: _____

Overview: _____

Learning Experiences:

1. _____

2. _____

3. _____

4. _____

5. _____

LEARNING ACTIVITY PACKAGE OUTLINE

Summary: _____

STUDENT EVALUATION CHECKLIST

Key: L = Limited skill
M = Moderate skill
P = Proficiency

S = Satisfactory
U = Unsatisfactory

Student Name: _____

Date: _____

Instructor: _____

RATING

CRITERIA

L M P Learning Activity: _____

S U Steps: 1. _____

S U 2. _____

S U 3. _____

S U 4. _____

S U 5. _____

STUDENT EVALUATION CHECKLIST – Continued

S U

6.

S U

7.

S U

8.

S U

9.

S U

10.

S U

11.

S U

12.

S U

13.

STUDENT EVALUATION CHECKLIST – Continued

S U

14.

S U

15.

S U

16.

S U

17.

S U

18.

S U

19.

S U

20.

SECTION 1.6

How to Select an Instructional Method

A better understanding of how people learn and the evolution of modern teaching and learning aids have resulted in the development of a variety of instructional methods. This section discusses eight of the most commonly used methods: lecture, conference, demonstration, performance, programmed instruction, study assignment, tutoring, and a combination of any of these.

Every instructional method has certain advantages and disadvantages, so it is important that the method selected is the one which will be most effective and efficient. Choosing an instructional method must be based on a careful analysis of the factors involved in the learning situation: instructional objectives, course content, student population, instructor, facilities, equipment, instructional materials, time, and costs. This section describes these factors as they relate to each of the eight instructional methods.

SELECTING AN INSTRUCTIONAL METHOD

Except for the selection of training objectives, the proper selection of instructional methods will do more to promote instructional efficiency and effectiveness than any other measure. Many times this fact is overlooked in training and education. All too often the selection of instructional methods is dictated by expediency rather than choice. An instructional method or methods must be selected through systematic means if inefficiency in attaining the course objectives—or worse, failure to achieve objectives—is to be avoided.

There is no single best method of teaching which applies to all learning situations or instructional objectives. The instructor must choose the method that is most compatible with the instructional objectives, the nature of the school organization, the facilities and equipment available, the

background and level of the students, and the instructor's own abilities.

Instructional Objectives. The accomplished instructor is one who has developed skill in using a great variety of instructional methods. For each course objective, the instructor can select from a variety of methods, one or more of which will lead to effective learning. The instructor who is limited in methods often tries to reach an objective by using inappropriate techniques. The result is a lack of student interest and attention, inefficient learning, or failure to achieve the instructional goals.

Too many instructors use only one or two methods. Many instructors lecture most of the time. Today, with the great variety of interesting and effective ways of helping students learn, the instructor should develop a repertoire of approaches. Then, rather than use the same methods for all lessons, he or she can draw from this repertoire the ones which are most appropriate for a particular situation.

Course Content. The nature of the course content must be considered in selecting an instructional method. The difficulty of the content and the kinds of skills and knowledge required determine to a great extent the methods which are most appropriate.

Student Population. The size of the student group and their educational level, prior training, aptitudes, maturity, and reading and speaking ability must be considered in selecting instructional methods.

Instructor. The number, quality, and competencies of available instructors is an important factor to consider in selecting instructional methods.

Facilities, Equipment, and Instructional Materials. Each instructional method requires the use

of specific types of facilities, equipment, and materials. If the proper facilities are not available, an alternative method may be required.

Time. The time available for a particular block of instruction also governs the method selected. If instructional time is extremely limited, an alternative to the most effective method may be required.

Costs. The costs involved in using a particular method cannot be separated from the other factors. Time, facilities, personnel, and equipment all involve costs. These factors must be taken into account when selecting instructional methods.

THE LECTURE METHOD

A lecture is a semiformal presentation by the instructor of a series of events, facts, concepts, or principles, an exploration of a problem, or an explanation of relationships. Students participate in a lecture mainly as listeners. A lecture is basically a means of telling students information they need to know. This does not mean, however, that all the talking done by the instructor during a class period can be termed a lecture. The term should be reserved to describe a more structured presentation which is used to achieve an instructional objective.

Uses. The purpose of a lecture is to inform. The instructor has information which he or she wishes to transmit to students by means of oral communication. Some of the more appropriate uses of the lecture are:

- to orient students to course policies, rules, procedures, purposes, and learning resources.
- to introduce a subject, indicate its importance, and present an overview of its scope.
- to give directions on procedures for use in subsequent learning activities.
- to present basic material which will provide a common background for subsequent activities.

- to set the stage for demonstration, discussion, or performance.
- to illustrate the application of rules, principles, or concepts.
- to review, clarify, emphasize, or summarize.

Advantages. A properly planned and skillfully delivered lecture is an effective method when used in appropriate situations. Some of the reasons why the lecture is one of the most widely used methods of instruction are that it:

- saves time. The lecture method saves time because the instructor can present more material in a given amount of time than he or she can by any other method.
- permits flexibility of class size. The size of a class is limited only by the size of the classroom to be used or the efficiency of the public address system.
- requires less rigid space requirements. The lecture can be used effectively in any type of training area, indoors or outdoors. The only requirement is that the trainees must be able to hear the lecturer.
- permits adaptability. A skillful lecturer can modify or adjust his or her materials' sequence, vocabulary, and illustrations to meet the needs of a specific group. This makes it possible to present content which is appropriate for the educational level, training, and past experience of the class.
- permits versatility. The lecture can be used for orientation, introduction, review, clarification, and summary. It can be used at any point in a course, and it can be combined easily and effectively with any other method of instruction.
- permits better control over content and sequence. Because the instructor determines what is to be presented and the order of presentation, the desired coverage and sequence can be accomplished with little danger of engaging in time-consuming detours.

Disadvantages. Some of the disadvantages of the lecture method are that it:

- involves one-way communication. The instructor prepares and presents the material. The student sits, listens, and takes notes. Most lectures, therefore, permit little or no interchange of ideas between the instructor and the students. All ideas presented to the class originate with the instructor.

- poses problems in skill teaching. The lecture method is an inappropriate way to teach skills such as equipment operation.

- appeals mainly to one sense. Most learning takes place through the visual sense. The lecture, even if supplemented by training aids, appeals mainly to the auditory sense. Unless the content is interesting and challenging enough to hold the attention of the class, the results are likely to fall short of the instructional goal.

- contributes to student passiveness. During a lecture, students are passive. Their job is to listen. Attention is difficult to attract and retain. Outside disturbances easily and frequently distract the students and make the lecture ineffective.

- poses evaluation problems. If an instructor is to teach rather than merely present information, he or she must be aware of student reactions, misconceptions, inattention, and difficulties, and he or she must remedy them immediately. The lecture method makes these perceptions difficult. Most students have acquired the ability to appear attentive, although they may not even be listening. The lecturer receives very little feedback, and much of what he or she does receive is often misleading.

- depends on the skill of the instructor. In a lecture, student interest and attention must be generated by the instructor. The instructor must plan carefully, display sincerity and enthusiasm, present material in a proper sequence, use appropriate vocabulary, employ effective speaking techniques, be sensitive to the reaction of the students, and modify the presentation on the

basis of class response. Failure to do any of these things will result in a loss of student attention and interest, and a failure to achieve the objectives of instruction. The ultimate success of a lecture depends on the skill of the instructor.

THE CONFERENCE METHOD

The conference is a method in which group discussion techniques are used to reach instructional objectives. These discussion techniques include questions, answers, and comments from the instructor in combination with questions, answers, and comments from the students, and are directed toward learning goals. There are three types of conferences: directed discussion, training conferences, and seminars. Clear distinctions do not exist between any of these forms; however, the objectives of the conference, and the kind and amount of student participation, determine when a directed discussion becomes a training conference, and when a training conference becomes a seminar.

The objective of a **directed discussion** is to help students acquire a better understanding of and develop an ability to apply known facts, principles, concepts, policies or procedures. The function of the instructor is to guide the student discussion in such a way that the facts, principles, concepts, or procedures are clearly articulated and applied.

In a **training conference**, the objective is to pool the knowledge and past experience of the students to arrive at improved or more clearly stated principles, concepts, policies or procedures. The topics discussed in a training conference are less likely to have pat answers than those used in a directed discussion. The task of the instructor is to elicit contributions from the group based on their past experiences which have a bearing on the topic at hand.

The purpose of the **seminar** is to find an answer to a question or a solution to a problem. The instructor does not have an answer or a solution; in fact, there is no known best or correct solution. Rather, the instructor is seeking an answer

and encourages the students to develop one. The primary functions of the instructor are to describe the problem as he or she understands it and to encourage free and full participation in a discussion aimed at: identifying the real problem, gathering and analyzing data, formulating and testing hypotheses, determining and evaluating alternative courses of action, arriving at conclusions, or making recommendations to support or arrive at a solution or a decision.

Uses. The conference method is a valuable tool in the instructor's kit. Some of the more important applications of this method are:

- to develop imaginative solutions to problems.
- to stimulate interest and thinking, and to secure student participation in situations which would otherwise allow the class to remain passive.
- to emphasize the main teaching points.
- to supplement lectures, readings or laboratory exercises.
- to determine how well students understand concepts and principles, and to determine if they are ready to proceed to new or more advanced material.
- to prepare students for the application of a theory or procedure to specific situations.
- to summarize, clarify, or review.
- to prepare students for subsequent instruction.
- to determine student progress and the effectiveness of prior instruction.

Advantages. Some of the advantages of the conference method are that it:

- increases student interest. The opportunity to express one's own views and to hear the opinions of others is stimulating. Interest is unusually high in a well-planned and skillfully conducted conference.

- increases student acceptance and commitment. Because students actively participate in developing the lesson, they tend to accept the importance and validity of the content and are more deeply committed to solutions or decisions than they would be if the content were merely presented to them.

- utilizes student knowledge and experience. The conference method enables the instructor to make effective use of the students' backgrounds, previously acquired knowledge, and experiences. The entire class and the instructor benefit from the experience and thinking of all students.

- results in more permanent learning. Learning takes place in direct ratio to the amount of individual participation in the learning process. The conference demands a high degree of student participation, thereby promoting better and more permanent learning.

Disadvantages. Some of the disadvantages of this method are that it:

- requires highly skilled instructors. The conference is more exacting of the resourcefulness, initiative, and ability of the instructor. The instructor must be able to guide the discussion without appearing to do so. He or she must be thoroughly informed on all aspects of the subject under discussion. The instructor must also: keep the discussion on the track, minimize debate over unimportant details, relate comments to topics previously discussed, avoid reopening topics already discussed, encourage and get full participation, prevent domination by a few students, summarize each topic, and bring the discussion to a close.

- requires preparation by students. Most conferences require advance preparation in the form of reading assignments, thinking, and study before the meeting. The thoroughness of the preparation determines the quality of the discussion and the outcome of the conference. Little or no instructor control can be insured over the quality or thoroughness of student preparation. This results in variation among students in their readiness to participate in the conference.

- limits content. The content appropriate for discussion is restricted. Manipulative operations, functions, procedures, or introductory materials do not ordinarily provide suitable content for a conference.

- consumes time. Relatively large blocks of time must be allocated if a discussion is to be profitable. For this reason, the conference is often ruled out as an approach although it may be well suited to the subject and the class.

- restricts size of group. The conference method cannot be used effectively with groups larger than 12 to 15 students, because the opportunity for individual participation is too limited. More reticent members are likely to be left out of the discussion and denied valuable learning experiences.

- requires selective group composition. The members of a conference group, in most cases, must possess the proper background, maturity, and motivation if the discussion is to be profitable. The desired degree of participation is difficult to obtain if the group is composed of one subgroup which has ample experience in the area to be discussed and another subgroup which has extremely limited experience.

THE DEMONSTRATION METHOD

A demonstration is a method of instruction where the instructor, by actually performing an operation or doing a job, shows the student what to do and how to do it, and through explanations brings out why, where, and when it is done. Usually the student is expected to be able to repeat the job or operation after the demonstration. For this reason, the demonstration is often used in conjunction with another method. The most common combinations are the lecture-demonstration and the demonstration-performance.

Uses. The basic purpose of a demonstration is to show how something is done. It should be employed wherever and whenever practicable. Some of its more important applications are:

- to teach manipulative operations or procedures, or how something is done.
- to teach problem-solving and analytical skills.
- to illustrate principles, or why something works.
- to teach the operation or functioning of equipment, or how something works.
- to teach teamwork, or how people work together to do something.
- to set standards of performance.
- to teach safety procedures.

Advantages. Some of the advantages of the demonstration method are that it:

- improves learning. Students learn faster and more permanently with a demonstration. A demonstration makes explanations concrete by giving meaning to words. Relationships between steps of a procedure and the accomplishment of the objective are clarified in a demonstration. Students not only see and hear during a demonstration, they are often given the opportunity to touch the equipment. When well planned and executed, a demonstration has a dramatic quality which arouses and sustains interest and attention.
- minimizes damage and waste. Equipment is often damaged when students attempt to operate it without proper guidance. Much of this damage and waste can be prevented by the use of demonstrations.
- saves time. A properly planned demonstration takes much less student time than other methods. It reduces oral explanation time and at the same time prevents misunderstandings about how a system or a piece of equipment works.
- can be presented to large groups. Class size is limited only by the ability of the group to see the object being demonstrated. The use of large-scale mockups or models makes it possible to teach many operations to large classes.

Disadvantages. Some of the disadvantages of this method are that it:

- requires careful preparation and rehearsal. A demonstration should set a standard of performance for students. The procedure must be technically correct and must be performed with a skill greater than that expected of students. The instructor must be sure that the equipment is in working order. Nothing fails as completely as a demonstration that doesn't work.

- requires special classroom arrangements. The demonstration room must be set up so that all students can clearly see every phase of the demonstration.

- requires equipment and aids. The equipment, often expensive, must be taken out of an operational setting. Therefore, the removal of this equipment must be offset by gains in training. Sometimes, models or mockups must be purchased or constructed. These represent a rather costly investment of time, money, and other resources.

THE PERFORMANCE METHOD

The performance method requires the student to perform, under controlled conditions, the operation, skill, or movement being taught. Performance is learning by doing.

There are four basic types of performance. **Independent practice** requires students to work individually at their own pace. In **group performance** or **controlled practice**, students work together step-by-step at the rate set by the instructor. The **coach and pupil** method involves pairing students. Members of each pair perform alternately as instructor and student. In **team performance**, a group of students perform an operation or function as a team.

Uses. In general, the performance method has the same applications as the demonstration method and is used as follow-on instruction:

- to teach manipulative operations or procedures.
- to teach the operation or functioning of equipment.
- to teach team skills.
- to teach safety procedures.

Advantages. The main advantages of the performance method are that it:

- builds confidence. Given the opportunity to apply their knowledge in a realistic situation, students develop confidence in their ability and a positive attitude toward the learning situation.

- increases learning. Active student participation is maximized. This fact, coupled with the interest and attention generated by putting theory into practice, increases both the amount and the permanence of learning.

- enables learning evaluation. With the performance method the instructor has an opportunity to observe the degree of learning attained by each student, to identify students having difficulty, and to determine if there have been weak areas in the instruction.

- reduces damage and waste. Because performance is guided, students are less likely to make mistakes which will damage equipment or waste materials.

- promotes safety. Guided performance makes it possible to emphasize the proper method of performance and helps prevent accidents.

Disadvantages. Some of the disadvantages of the performance method are that it:

- requires tools and equipment. If a practical exercise is to be conducted, every student must participate fully. Therefore, tools and properly functioning equipment must be available in sufficient quantity for the size of the class.

- requires large blocks of time. A well-run practical exercise is often time-consuming in its requirements for setting up the room and equipment, and in accomplishing the actual setting up of the room and equipment for individual or team performance of the complete operation.

- requires more instructors. Unless the class is very small, a number of qualified instructors are required to keep a constant check on the progress of each student, to give assistance when needed, and to evaluate the quality of the performance.

PROGRAMMED INSTRUCTION METHOD

Programmed instruction is a method of self-instruction in which the student works through a carefully sequenced and pretested series of steps leading to the acquisition of knowledge or skills representing the instructional objectives. The student proceeds through the program at his or her own rate, responds actively to each step in the sequence, and receives immediate feedback on the correctness of his or her response before proceeding to the next step. Programs are usually designed to permit the student to master the desired knowledge or skills.

Uses. The programmed instruction method can be used:

- to provide remedial instruction.
- to provide makeup instruction for late arrivals, absentees, or transients.
- to maintain previously learned skills which are not performed frequently enough to insure an acceptable level of proficiency.
- to provide retraining on equipment and procedures which have become obsolete or have been replaced since the original training was given.
- to upgrade production, administrative, or other types of skills and knowledges.

- to accelerate capable students and thereby enable them to complete a course in less than the usual amount of time.

- to provide a means of insuring enough common background among students to profit from formal classroom work.

- to provide the review and practice of knowledge and skills needed to "set" the learning.

- to provide a source of vertical enrichment (advanced work) or horizontal enrichment (broader contact) in a content area.

- to control the variables in a learning situation for experimental purposes.

Advantages. The advantages of programmed instruction are that it:

- reduces the failure rate. The student failure rate is reduced because programs are tested and validated before they are used. This procedure insures that the program is effective in performing the instructional job. The self-pacing feature of the material also helps, because students are exposed to the material at a rate which is appropriate for each individual. The "forced" response and immediate confirmation features guarantee continuous attention to the material, correct wrong responses, and prevent misinterpretation and the practice of errors.

- improves end-of-course proficiency. The pre-testing, self-pacing, forced attention, and immediate feedback features of programs result in better, more efficient, and more permanent learning. Thus, end-of-course proficiency is markedly increased.

- saves time. The rigid control over content made possible by the procedures used for developing, testing, and validating programs prevents the introduction of unnecessary content and thereby reduces the time required to learn the critical material. The self-pacing feature, along with forced attention, decreases the teaching time required, and frequently results in an average time savings of 30 percent or more over conventional instructional methods.

- **standardizes instruction.** The instructional content and sequence of a program are predetermined. They are not subject to the whims, preferences, experiences, or biases of the instructor. The quality of instruction does not vary from day to day nor from instructor to instructor. There is almost complete control over the content, sequence, and form of student responses. Hence, instruction becomes standardized and can be repeated without change at any time for any individual or group.

- **requires no special facilities.** Programmed materials can be used anywhere at any time. No specially equipped rooms or facilities are necessary.

- **provides for self-instruction.** Although under ordinary conditions programs are not used as substitutes for instructors, they can be so used. Programs are validated under conditions where they alone do the teaching. Therefore, they are effective instructional materials even if no qualified instructor is available.

- **accommodates student differences.** Programs can be designed to accommodate wide differences in aptitude, ability, speed of learning, prior training, and experience. The needs of students, whether for more or less exposure, detail, or practice, can be met. The size of a class is also unimportant. Programs can be used to achieve group or individual progress.

- **improves efficiency and economy for group or individual instruction.** The self-pacing feature and the handling of large or small groups make for greater efficiency and economy. In addition, programs free instructors from routine, repetitive teaching tasks and enable them to spend a larger part of their time on more difficult or more demanding aspects of instruction.

Disadvantages. The disadvantages of the programmed instruction method are that it:

- **requires local or commercial preparation.** Although the number of available programs is growing rapidly, those which may be used

locally are limited. Most programs produced by commercial publishers or other sources do not match the instructional objectives of local courses. For this reason, programs must be developed locally or contracted with commercial programming companies.

- **requires lengthy programmer training.** Very few trained programmers are available locally. The training program is relatively lengthy and demanding. Only a small percentage of persons exposed to programmer training will become competent programmers.

- **increases expenses.** Programs, whether developed locally or contracted, are extremely costly. For local development there must be a large investment in programmer training and an even larger one in program writing, testing, and validation. Program development by contract is expensive, and the time required by subject-matter experts and technicians for consulting with programmers and reviewing draft materials is considerable.

- **requires considerable lead time.** Programmed materials cannot be selected or developed quickly. Lead time is required to screen and select appropriate programs from those available. If programs are developed by school staff or contract programmers, the lead time for production, testing, and validation is even greater. If the course content is unstable or subject to frequent and radical change, it is inappropriate for programming.

- **demands competent instructors.** Instructors must be able to motivate students to complete programs. They must be able to assist any student at any point in the programmed sequence. If instructors are to be able to provide the motivation, guidance, and assistance required for the optimum use of programmed materials, they must have: insight into the learning process; a thorough understanding of the rationale, principles, construction, and use of programming; skill in conducting tutorial-type instruction and individual counseling; and a mastery of the subject matter of the programs used.

- requires mature students. The use of programs requires a student group which is mature enough and sufficiently well motivated to work independently. Also, they must be able to read at the level required for full understanding of the program.

- poses administrative problems. The use of programmed materials creates unique administrative problems. Foremost among these are the scheduling and assignment problems caused by the self-pacing feature of programs. This feature results in different phase and course completion times with consequent difficulties in scheduling following instruction and assigning graduates to field units.

THE STUDY ASSIGNMENT METHOD

The study assignment is a method in which the instructor assigns readings in books, periodicals, manuals, or handouts; requires the completion of a project or research paper; or assigns problems and exercises for the practice of a skill. This method involves imposing a task, providing for student motivation, and giving general directions for carrying out the assignment. Implicit in this method are the problems of setting up worthwhile learning activities and anticipating student difficulties and means of overcoming them. If these steps are not well handled, the objectives of the assignment are not likely to be achieved.

The study assignment has two basic forms. In an **independent study** the student carries out the assignment without instructor assistance or direct guidance. In a **supervised study** the student carries out the assignment with an instructor available for guidance and assistance.

Uses. The study assignment method can be used:

- to orient students to a topic prior to classroom or laboratory work.
- to set the stage for a lecture, demonstration, or discussion.

- to provide for or capitalize on individual differences in ability, background, or experience through differentiated assignments.
- to provide for the review of material covered in class or to give the practice essential for the development of skills and problem-solving ability.
- to provide enrichment material.

Advantages. Some of the advantages of the study assignment method are that it:

- increases coverage of material. A far greater amount of material, and detailed treatment of it, can be covered in a shorter period of time by study assignments than by any other means.
- reduces classroom time. Used properly, study assignments can serve as a substitute for lectures; study assignments can make lectures, demonstrations, and conferences more meaningful and more productive.
- improves learning. Practice is essential to the development of skills. Study assignments provide a means of giving enough practice to insure mastery of the skill.
- permits individualized attention. Study assignments can be designed to make use of the experience, special skills, or interests of students, or to remedy individual deficiencies in skill or knowledge.
- reduces instructor interpretation. Students may be referred to the original source instead of being exposed only to the instructor's interpretation. This insures that the content will be presented as intended by the originator of the material.

Disadvantages. Some of the disadvantages of this method are that it:

- requires careful planning and follow-up. If students are not well motivated, they are not likely to do a thorough job with assignments, especially those which they must do on their

own. The instructor must plan and assign work in such a way that the objectives and instructions are clear and the motivation is present. The instructor also must follow up to insure that the assignment has been carried out.

- poses evaluation problems. The effectiveness of study assignments is difficult for an instructor to evaluate. It is also difficult for him or her to determine what went wrong with a study assignment when the results are not as good as anticipated.

- results in the practice of errors. In skill development it is critical that the skill be practiced in the prescribed mode. Particularly with independent practice, there is a danger that the student will practice an incorrect procedure or error. When this occurs, a large expenditure of time is required to "unlearn" the skill and "relearn" it correctly.

- produces nonstandard results. The variations in reading ability and differences in motivation in any group produce varying degrees of learning when study assignments are used. Where standardization of learning is essential, study assignments may be inappropriate.

THE TUTORING METHOD

Tutoring is a method of instruction in which an instructor works directly with an individual student. The method may involve exposition, demonstration, questioning, coaching, or guided practice.

Uses. Tutoring can be used:

- to teach highly complex skills and operations, or operations which involve potential danger to students or hazards to expensive equipment.
- to provide individualized remedial assistance.

Advantages. Some of the advantages of tutoring are that it:

- permits adaptive instruction. Tutoring provides the optimum in individualized instruction. The needs of the individual student can be diagnosed and instruction can be tailored to meet his or her unique needs.

- stimulates active participation. In a tutorial setting, the highest possible degree of student participation can be achieved. Direct involvement in the learning, by answering and asking questions, by performing under supervision, is guaranteed.

- promotes effective learning. The ability of the tutor to adapt instruction to the needs of the individual, together with the high degree of interaction and participation of the student, make this method extremely effective in achieving instructional objectives.

- promotes safety. The one-to-one instructor-student ratio provides close control over performance of hazardous operations, resulting in the prevention of injury to the operator or damage to the equipment.

Disadvantages. Some of the disadvantages of this method are that it:

- requires highly competent instructors. Tutoring is one of the most demanding types of instruction to conduct. It requires complete mastery of the content and skill in diagnosing and remedying learning difficulties.

- demands time and money. Tutoring is probably the most expensive method of teaching. Although only one student is receiving instruction, instructor preparation and presentation time are essentially the same as they would be for a whole class of students.

THE COMBINATION METHOD

This is a method of instruction which uses two or more basic instructional methods in combination. For example, one lesson might include a study assignment, a lecture in which safety precautions in handling a piece of equipment are

emphasized, a demonstration by the instructor, and, finally, performance by the students.

Uses. Combination lessons can be used to meet almost any type of instructional objective in any training situation. However, they are most appropriate where skill development is involved.

Advantages. The advantages of using a combination of methods are that they:

- increase interest. The variety of methods used in a combination lesson make for a more interesting and engaging instructional period.
- promote flexibility. The use of several methods frees the instructor from the restricting or limiting aspects of any single method. He or she can easily adjust the lesson to the needs of the class and the requirements of the situation.

- improve learning. The combination lesson maximizes the advantages of any single method. It allows the instructor to use approaches which complement each other. This fact, plus the advantage of higher student interest, results in improved learning.

Disadvantages. The disadvantages of using a combination of methods are that they:

- require highly skilled instructors. Instructors must be able to use all methods of instruction with a high degree of skill.
- require smaller groups. The use of methods in combination requires closer control by the instructor and better supervision of student activities. To obtain the desired control, classes must be kept small.

SECTION 1.7

Teaching-Learning Resources for the Instructor

Section 1.7 provides the instructor with a list of the major career field and guidance associations and the principal manufacturers of a variety of business machines. The associations and manufacturers may be contacted as sources of audio-visual, texts, and reference materials as well as information on career opportunities within the field of business machine repair.

ASSOCIATIONS

American Association for Vocational Instructional Materials, Engineering Center, Athens, GA 30602

American Industrial Arts Association, 1201 Sixteenth Street, NW, Washington, DC 20036

American Technical Education Association, North Dakota State School of Science, Wahpeton, ND 58075

American Vocational Association, Inc., 1510 H Street, NW, Washington, DC 20005

Computer and Business Equipment Manufacturers Association, 1828 L Street, NW, Washington, DC 20036

International Word Processing Association, Maryland Road, AMS Building, Willow Grove, PA 19090

Marking Device Association, 708 Church Street, Evanston, IL 60201

National Association of Industrial and Technical Teacher Educators, Kearney State College, Kearney, NE 68847

National Association of State Supervisors of Trade and Industrial Education, 1510 H Street, NW, Washington, DC 20005

National Employment Counselors Association, 1607 New Hampshire Avenue, NW, Washington, DC 20009

National Micrographics Association, 8728 Colesville Road, Suite 1101, Silver Spring, MD 20910

National Office Machine Dealers Association, 1510 Jarvis Avenue, Elk Grove Village, IL 60007

National Vocational Guidance Association, 1607 New Hampshire Avenue, NW, Washington, DC 20009

Vocational Industrial Clubs of America, 105 North Virginia Avenue, Falls Church, VA 22046

Word Processing Institute, 37 West 72nd Street, New York, NY 10023

MANUFACTURERS

Accounting Machines

Facit-Addo, Inc., 66 Field Point Road, Greenwich, CT 06830

Monroe, The Calculator Company, Division of Litton Industries, Inc., P.O. Box 9000R, Morristown, NJ 07960

Olivetti Corporation of America, 500 Park Avenue, New York, NY 10022

Adding Machines

Addmaster Corporation, 416 Junipero Serra Drive, San Gabriel, CA 91776

Adler Business Machines Inc., Division of Litton Industries, 1600 Route 22, Union, NJ 07083

R. C. Allen Inc., 678 Front Avenue NW, Grand Rapids, MI 49501

Facit-Addo, Inc., 66 Field Point Road, Greenwich, CT 06830

NCR Corporation, Office Products Division, Main and K Streets, Dayton, OH 45409

Olivetti Corporation of America, 500 Park Avenue, New York, NY 10022

Olympia USA, Inc., P.O. Box 22, Somerville, NJ 08876

Sperry Remington Office Machines, Division of Sperry Rand Corporation, P.O. Box 1000, Blue Bell, PA 19422

Unitrex of America, Inc., 689 Fifth Avenue, New York, NY 10022

Victor Comptometer Corporation, Business Products Group, 3900 North Rockwell Street, Chicago, IL 60618

Addressing Machines

Addressograph Multigraph Corporation, 7209 St. Clair Avenue, Cleveland, OH 44103

A. B. Dick Company, 5700 West Touhy Avenue, Chicago, IL 60648

Edit Systems Inc., 1353 North Main Street, Ann Arbor, MI 48104

Heyer Inc., 1850 South Kostner Avenue, Chicago, IL 60623

Master Addresser Company, 7506 West 27th Street, Minneapolis, MN 55426

Speed-O-Print Business Machines Corporation, 1801 West Larchmont Avenue, Chicago, IL 60613

Stielow Addressing Systems, 100 North Sixth Street, Minneapolis, MN 55403

Bookkeeping Machines

American Bank Equipment Company, 5408-10 West Jefferson Street, Philadelphia, PA 19131

Facit-Addo, Inc., 66 Field Point Road, Greenwich, CT 06830

NCR Corporation, Office Products Division, Main and K Streets, Dayton, OH 45409

Olivetti Corporation of America, 500 Park Avenue, New York, NY 10022

Calculating Machines

Busicom U.S.A., Inc., 86-02 57th Avenue, Elmhurst, NY 11373

Cimatron Company, Division of Citizen America Corporation, 1710 22nd Street, Santa Monica, CA 90404

K. G. Diehl Calculating Systems, 540 Madison Avenue, New York, NY 10022

Facit-Addo, Inc., 66 Field Point Road, Greenwich, CT 06830

G. W. Industries Inc., 1675 East Del Amo Boulevard, Carson, CA 90746

Olivetti Corporation of America, 500 Park Avenue, New York, NY 10022

3-D Wholesale Office Machines, 2240 Colby Avenue, Los Angeles, CA 90064

Cash Registers

Addmaster Corporation, 416 Junipero Serra Drive, San Gabriel, CA 91776

R. C. Allen Inc., 678 Front Avenue NW, Grand Rapids, MI 49501

Anker Data Systems, 2021 Swift Drive, Oak Brook, IL 60521

NCR Corporation, Office Products Division, Main and K Streets, Dayton, OH 45409

Sperry Remington Office Machines, Division of Sperry Rand Corporation, P.O. Box 1000, Blue Bell, PA 19422

Victor Comptometer Corporation, Business Products Group, 2000 North Rockwell Street, Chicago, IL 60618

Collating Machines

The Challenge Machinery Company, 1433 Fulton Street, Grand Haven, MI 49417
A. B. Dick Company, 5700 West Touhy Avenue, Chicago, IL 60648
General Binding Corporation, 1101 Skokie Boulevard, Northbrook, IL 60062
Gestetner Corporation, Gestetner Park, Yonkers, NY 10703
Martin Yale Business Machines, 500 North Spaulding Avenue, Chicago, IL 60624
Michael Business Machines Corporation, 145 West 45th Street, New York, NY 10036
NSC International Corporation, 257 Winans, Box 1800, Hot Springs, AR 71901
Ordibel Collators, Inc., 90 Park Avenue, New York, NY 10016
Standard Duplicating Machines Corporation, 1935 Revere Beach Parkway, Everett, MA 02149
Swingline, Inc., 32-00 Skillman Avenue, Long Island City, NY 11101
Tiffany Associates, 6 Bridewell Place, Clifton, NY 07014

Copying Machines

Addressograph Multigraph Corporation, 7209 St. Clair Avenue, Cleveland, OH 44103
Albin Industries, Inc., P.O. Box 346, Farmington, MI 48024
Apeco Corporation, 2100 West Dempster Street, Evanston, IL 60204
Bell & Howell Business Equipment Group, 6800 McCormick Road, Chicago, IL 60645
Bruning Division, Addressograph Multigraph Corporation, 1834 Walden Office Square, Schaumburg, IL 60172
Copy-Plus, Inc., 2817 West Carmen Avenue, Milwaukee, WI 53209
A. B. Dick Company, 5700 West Touhy Avenue, Chicago, IL 60648
Gestetner Corporation, Gestetner Park, Yonkers, NY 10703
Graphics Communications Corporation, 25 Graphic Place, Moonachie, NY 07074
Itek Graphic Products, 1001 Jefferson Road, Rochester, NY 14603
Minolta Corporation, Business Equipment Division, 101 Williams Drive, Ramsey, NY 07446

Olivetti Corporation of America, 500 Park Avenue, New York, NY 10022

Pitney Bowes, Walnut and Pacific Streets, Stamford, CT 06904

SCM Copier Products, Business Equipment Division, 299 Park Avenue, New York, NY 10017

SCR Corporation, 102 Hobart Street, Hackensack, NJ 07601

Speed-O-Print Business Machines Corporation, 1801 West Larchmont Avenue, Chicago, IL 60613

Sperry Remington Office Machines, Division of Sperry Rand Corporation, P.O. Box 1000, Blue Bell, PA 19422

3M Corporation, 3M Center, St. Paul, MN 55101

Toshiba America, Inc., Business Equipment Division, 280 Park Avenue, New York, NY 10017

Yorktown Industries, Inc., 330 Factory Road, Addison, IL 60101

Dictating Machines

American Dictating Machines, Inc., 20 West 23rd Street, New York, NY 10010

Dictaphone Corporation, 120 Old Post Road, Rye, NY 10580

Dictran International Corporation, 467 Forbes Boulevard, South San Francisco, CA 94080

Memocord, USA, 10 Dwight Place, Fairfield, NJ 07006

Olympia USA, Inc., P.O. Box 22, Somerville, NJ 08876

Philips Business Systems, Inc., 175 Froehlich Farm Boulevard, Woodbury, NY 11797

Sony Corporation of America, Business Products Division, 47-47 Van Dam Street, Long Island City, NY 11101

3-D Wholesale Office Machines, 2240 Colby Avenue, Los Angeles, CA 90064

3M Corporation, 3M Center, St. Paul, MN 55101

Unitrex of America, Inc., 689 Fifth Avenue, New York, NY 10022

Letter Folding Machines

Addressograph Multigraph Corporation, 7209 St. Clair Avenue, Cleveland, OH 44103

Bell & Howell Business Equipment Group, 6800 McCormick Road, Chicago, IL 60645

The Challenge Machinery Company, 1433 Fulton Street, Grand Haven, MI 49417

A. B. Dick Company, 5700 West Touhy Avenue, Chicago, IL 60648

Gestetner Corporation, Gestetner Park, Yonkers, NY 10703

Martin Yale Business Machines, 500 North Spaulding Avenue, Chicago, IL 60624

Ordibel Collators, Inc., 90 Park Avenue, New York, NY 10016

Print-O-Matic Company, Inc., 724 West Washington Boulevard, Chicago, IL 60606

Envelope Openers

Ads-Postalia Division, Ads-Anker Data Systems, Midwest Inc., 2021 Swift Drive, Oak Brook, IL 60521

Automation Fastening Company, Inc., 1138 West Ninth Street, Cleveland, OH 44113

Ever-Ready International, Ltd., 1218 West Madison Street, Chicago, IL 60607

Martin Yale Business Machines, 500 North Spaulding Avenue, Chicago, IL 60624

Matsushita Electric Corporation of America, 200 Park Avenue, New York, NY 10017

Singer Business Machines, 2350 Washington Avenue, San Leandro, CA 94577

Speed-O-Print Business Machines Corporation, 1801 West Larchmont Avenue, Chicago, IL 60613

Postage Metering Machines

Ads-Postalia Division, Ads-Anker Data Systems, Midwest Inc., 2021 Swift Drive, Oak Brook, IL 60521

Automation Fastening Company, Inc., 1138 West Ninth Street, Cleveland, OH 44113

Pitney Bowes, Walnut and Pacific Streets, Stamford, CT 06904

The Singer Company, Mailing Equipment Division, 538 McCormick Street, San Leandro, CA 94577

Typewriter Repair Kits

Ames Supply Company, 2537 Curtiss Street, Downers Grove, IL 60515

Knickerbocker Case Corporation, 2950 West Chicago Avenue, Chicago, IL 60622

Typewriter Equipment Company, Inc., 25 Park Place, New York, NY 10007

Sorting Machines

NCR Corporation, Office Products Division, Main and K Streets, Dayton, OH 45409

Universal Business Machines, Inc., P.O. Box 6616, Columbia, SC 29260

Typewriter Cleaning Machines

Ames Supply Company, 2537 Curtiss Street, Downers Grove, IL 60515

Falcon Safety Products, Inc., 1137 Route 22, Mountainside, NJ 07092

Graymills Corporation, 3705 North Lincoln Avenue, Chicago, IL 60613

Magnus Division, Economics Laboratory, Inc., 370 Wabasha Avenue, Osborn Building, St. Paul, MN 55102

Wichita Sheet Metal Supply Inc., 1030 North Washington, Box 2517, Wichita, KS 67201

Automatic Repetitive Typewriters

American Automatic Typewriter Company, 2323 North Pulaski Road, Chicago, IL 60639

Edit Systems Inc., 1353 North Main Street, Ann Arbor, MI 48104

ICP, Inc., 2925 Merrell Road, Dallas, TX 75229

Olivetti Corporation of America, 500 Park Avenue, New York, NY 10022

3-D Wholesale Office Machines, 2240 Colby Avenue, Los Angeles, CA 90064

3M Corporation, 3M Center, St. Paul, MN 55101

Justifying Typewriters

Edit Systems Inc., 1353 North Main Street, Ann Arbor, MI 48104

Olivetti Corporation of America, 500 Park Avenue, New York, NY 10022

Olympia USA, Inc., P.O. Box 22, Somerville, NJ 08876

Singer Business Machines, 2350 Washington Avenue, San Leandro, CA 94577

3-D Wholesale Office Machines, 2240 Colby Avenue, Los Angeles, CA 90064

Standard Electric Typewriters

Adler Business Machines Inc., Division of Litton Industries, 1600 Route 22, Union, NJ 07083

Brother International Corporation, 680 Fifth Avenue, New York, NY 10019

Facit-Addo, Inc., 66 Field Point Road, Greenwich, CT 06830

Hermes Products, Inc., 1900 Lower Road, Linden, NJ 07036

Olivetti Corporation of America, 500 Park Avenue, New York, NY 10022

Olympia USA, Inc., P.O. Box 22, Somerville, NJ 08876

Royal Typewriter Company, Division of Litton Industries, 150 New Park Avenue, Hartford, CT 06106

SCM Corporation, 299 Park Avenue, New York, NY 10017

Sperry Remington Office Machines, Division of Sperry Rand Corporation, P.O. Box 1000, Blue Bell, PA 19422

3-D Wholesale Office Machines, 2240 Colby Avenue, Los Angeles, CA 90064

PART TWO
GUIDE FOR STUDENT SELECTION
AND
PLACEMENT IN THE TRAINING PROGRAM

SECTION 2.1

How to Use Part Two of the Guide

Part Two of the guide offers the secondary school guidance counselor important career information and recommends a set of steps that can be used to determine criteria for student selection and placement in the training program. The guidance counselor should become familiar with the sections presented in Part Two so that effective guidance activities, corresponding to the intent of the curriculum, can be carried out. In addition, Sections 1.2 and 1.3 of Part One are essential to the guidance process and should be reviewed by the counselor.

STEP 1: Review how the guide was developed. Read Section 1.2, "How the Guide Was Developed," to gain a thorough understanding of the structure and development of the guide and to become familiar with these key concepts and terms: occupational analysis, career ladder, worker trait group, task statement, and task inventory.

STEP 2: Review the information on the career field. Read Section 1.3, "General Job Description: Business Machine Repairer," for a comprehensive overview of the career field, descriptions of the type of work performed, employment forecasts, and other important career information.

STEP 3: Know the use and function of the Dictionary of Occupational Titles. If you have not already done so, you should become familiar with the use and function of the Dictionary of Occupational Titles and its supplements, which are available from the U.S. Department of Labor. These documents are the foundation upon which the business machine repair training program and guidance activities are built.

STEP 4: Study the qualifications profile. Section 2.3, "Qualifications Profile for the Entry-Level Business Machine Repairer," presents a composite profile of the entry-level worker and is based on the principal worker trait groups

associated with the career field from the Dictionary of Occupational Titles. This profile can be used in preliminary screening activities and in counseling students who want to enter the training program. Section 2.5, "Worker Trait Codification System," explains in full the knowledge, aptitude, and interest levels associated with these worker traits.

STEP 5: Determine the General Educational Development (GED) level of students. One part of the qualifications profile is a suggested level of competence related to general educational development. Section 2.2, "Career Guidance for Business Machine Repair Occupations," includes a description of the General Aptitude Test Battery (GATB) which can be used to determine the GED level of students as well as their aptitudes and interests.

STEP 6: Use the Advanced General Education Program for GED remediation. Section 2.4 provides a description and list of instructional units contained in the Advanced General Education Program. All or parts of this program can be used for remediation purposes based on the administration of the GATB.

STEP 7: Provide guidance for students who leave the program or who do not qualify. The results of the GATB, when used in conjunction with the qualifications profile, provide a useful starting point for counseling students who drop out of the business machine repair program or whose interests, aptitudes, and GED level do not seem appropriate for the career field.

STEP 8: Coordinate your guidance activities with the instructor. Review the sections in Part One of the guide to gain an understanding of how the curriculum and instructional development activities correspond to the recommended guidance activities. Discuss student selection and placement activities with the instructor in order to better coordinate your efforts.

SECTION 2.2

Career Guidance for Business Machine Repair Occupations

Part Two of this guide is based on an extensive pool of career and job information maintained by the U.S. Employment Service and the Department of Labor. This and associated information is widely used by federal, state, and local governments, industry, private agencies, companies and institutions in hiring and placing workers and in defining worker duties, tasks, and activities.

By using Part Two in conjunction with the General Job Description (Section 1.3) and the Inventory of Job Tasks and Learning Objectives (Section 1.4), the guidance counselor will be able to:

- provide students with useful career decision-making information based on their interests, aptitudes, and previous educational experience.
- determine the General Educational Development (GED) level of individual students as it relates to the career field.
- determine the prerequisite learning needs of a student prior to his or her placement in the training program.

The guidance materials are a response to the many social factors which converge to stimulate interest in the career development needs of young people. All of these factors have in common the search for a set of values which will give meaning and usefulness to students' lives. Among the most important of these social factors are:

- the growing complexity in the occupational and organizational structure of society which makes it difficult for a person to assimilate and organize the data necessary to choose a career.
- the increasingly rapid rate of technological change which demands human adaptability and responsiveness.

- the increasing national concern for developing all human talent regardless of sex, age, religion, or ethnic origin.
- the need for specialized training to obtain entry-level jobs.
- the apparent disenchantment expressed by students who have difficulty relating their education to their lives.

The evolving view of a job is that it should be considered as one step in an integrated, life-long career. A job is a step on a career lattice involving both horizontal and vertical dimensions: horizontally, it involves a pattern of choices at one point in time; vertically, it involves choices over a period of time.

Career guidance should not be viewed as a static, tradition-based set of services that assists students in making simple occupational choices. Guidance must be developed from an initial assessment of the present and future career needs of students and must account for changes in the career field that could affect the development and fulfillment of students' expectations. The content of a guidance program can be organized in many ways to facilitate the student's development. Whatever its form, however, the program ultimately should encourage a student to assume responsibility for his or her own career development.

A career guidance program based on the counselor's experience, expertise, and use of the information presented here will help the student assimilate and integrate knowledge, experience, and appreciation related to the following career development efforts:

- self-understanding, which includes a person's relationships to his or her own characteristics and perceptions, to others, and to the society.

- an understanding of the world of work and those factors that affect its constant changing, including worker attitudes and disciplines.
- an understanding of the many factors to be considered in career planning.
- an understanding of the information and skills necessary to achieve self-fulfillment in work and leisure.

Section 2.2 is intended to facilitate the process of placing students in the training program. It provides techniques for determining the General Educational Development (GED) level of an individual and relating it to the GED level required for the job. Also presented is a description of the General Aptitude Test Battery, which can be used to determine students' aptitude and interest levels.

DEFINITION OF GENERAL EDUCATIONAL DEVELOPMENT*

General Educational Development (GED) can be defined as education of a general academic nature, ordinarily obtained in elementary school, high school, or college, which does not have a recognized, fairly specific occupational objective; this type of education also may be derived from experience or self-directed study. GED is composed of three types of development: reasoning, mathematical, and language.

Reasoning development involves the capacity to comprehend concepts and systems, solve problems, exercise judgment, and understand and carry out instructions, as well as to adapt to social and work environments.

Mathematical development is the acquisition of basic mathematical skills, not specifically vocationally oriented, such as solving arithmetic, algebraic, and geometric problems.

* Excerpted from "Relating General Educational Development to Career Planning," U.S. Dept. of Labor, Manpower Administration.

Language development includes the acquisition of language skills, not specifically vocationally oriented, such as mastery of an extensive vocabulary; use of correct sentence structure, punctuation, and spelling; and an appreciation of literature.

Mathematical and language development are "tool languages" which, although not specifically vocationally oriented, involve basic preparation for specific vocational goals. The descriptions of the various levels of language and mathematical development (see Section 2.5) are based on the curricula being taught at specified grade levels in schools throughout the country. An analysis of mathematics courses in the school curricula revealed distinct levels of progression in the primary and secondary grades and in college. These levels of progression facilitated the selection and assignment of six levels of GED for the mathematical development scale.

Though language courses follow a similar pattern of progression through completion of high school, consisting primarily of learning and applying the principles of grammar, this pattern breaks down at the college level. The diversity of fields of study at the college level precluded establishment of distinct levels of language development for these four years. Consequently, both GED Level 5 and Level 6 are defined by one language curriculum.

USING THE GED LEVELS FOR STUDENT PLACEMENT

In matching the student to the occupational program, it is essential to obtain all occupationally significant information about the student. Appraisal of the student in terms of his or her GED is based on such data as:

- school achievement, including grade level attained, subjects studied, standing in class, and honors or special recognition in specific subjects.
- special courses, either military or civilian.

- results of tests which measure the degree of academic achievement or general intelligence.
- vocational and personal achievements in any previous work situations.
- general demeanor and ability to communicate.

These data can be related to an appropriate academic level on the GED chart in Section 2.5. For example, a student who has completed the eighth grade in school and achieved a B average in arithmetic, with C's and B's in other subjects, appears to be at an academic level which relates to GED Level 3.

If more information is needed to make a final determination, the guidance counselor can probe into the courses studied by the student to insure that the school curriculum meets the standards reflected in the curriculum for Level 3 on the GED chart. It should be remembered that a student sometimes has a higher educational development than his or her formal education presupposes, and in such a case he or she should be identified at a higher, more appropriate level.

The primary purpose of determining the GED level of a student is to provide a criterion for use with other information in relating him or her to suitable vocational goals, whether through immediate employment or through additional education and training. All information about the student—the evaluation of his or her aptitudes, interests, and personality characteristics, GED level, and any test results—can be related to areas of work, groups of jobs, and specific jobs in the Worker Traits Arrangement of the Dictionary of Occupational Titles. The most important information relating to business machine repair occupations and worker trait groups is presented in Section 2.3. (A more detailed description of the worker trait codification system appears in Section 2.5.)

The qualifications profile in Section 2.3 includes the GED reasoning, mathematical, and language development levels required for entry-level business machine repairers. These GED levels indicate the degree of educational development,

formal or otherwise, which the worker should possess for average satisfactory job performance. By relating the GED level of the student to that required for the business machine repairer, the guidance counselor can do a better job of helping students select vocational goals.

The subject matter areas listed in the GED chart in Section 2.5 can be used in planning basic or supplementary general education for students in the training program or advising a student on the educational basis required for functioning in this career field.

The GED levels listed in the qualifications profile in Section 2.3 constitute the prerequisites for effective job performance at the entry level. Should the prerequisite GED be missing in a candidate for business machine repair training, then the student should be directed to a more appropriate program of occupational training.

If the student is selected for the training program on the basis of other criteria, then steps must be taken to provide him or her with academic training that will raise his or her GED to the desired level. Otherwise, the student will be handicapped in his or her ability to handle the course content of the training program and to perform the required duties and tasks while on the job.

A student who is deficient in prerequisite GED should be encouraged to participate in the Advanced General Education Program (see Section 2.4) either before becoming involved in training or during the business machine repair training program.

GENERAL APTITUDE TEST BATTERY

Another useful tool in placing students in the business machine repair training program is the General Aptitude Test Battery (GATB). The GATB was developed in conjunction with the occupational counseling services of the U.S. Employment Service. According to its developers, the GATB "is designed to measure several aptitudes which have been found important to success in many occupations." The

battery is used primarily as an aid in the more effective placement of applicants who have insufficient job experience. Various state agencies, in cooperation with local school authorities, have been extending the application of the battery to the counseling of high school students.

The battery consists of 15 tests: 11 paper-and-pencil and four apparatus tests. It requires approximately 2½ hours for completion. The tests are designed to measure nine basic aptitudes for 20 fields of work including approximately 2,000 of the occupations classified in the Dictionary of Occupational Titles (D.O.T.). The nine apti-

tudes are: Intelligence (G), Numerical (N), Verbal (V), Spatial (S), Form Perception (P), Clerical Perception (Q), Motor Speed (T), Finger Dexterity (F), and Manual Dexterity (M).

The qualifications profile presented in Section 2.3 of this guide is derived from the D.O.T. and relates directly to the aptitudes measured in the GATB. For more information on obtaining, administering, and interpreting the results of the General Aptitude Test Battery, contact the local office of the Illinois State Employment Office.

SECTION 2.3

Qualifications Profile

for the Entry-Level Business Machine Repairer

The qualifications profile contained in this section of the guide is based on an analysis of the essential worker traits for the entry-level business machine repairer. The analysis utilized the Dictionary of Occupational Titles and was supplemented by the Handbook for Analyzing Jobs and the Handbook on Relating General Educational Development to Career Planning. All three documents are publications of the U.S. Department of Labor.

Worker traits are defined as the abilities, personal traits, and individual characteristics necessary for a worker to achieve average successful job performance. The qualifications profile provides the broadest and most comprehensive framework for the effective presentation of worker trait information in the career field.

This profile, and the task and objective inventory developed around it (see Section 1.4), are seen as a natural basis upon which to select students for training and provide career counseling. Within this framework, the guidance counselor will find a qualifications profile which indicates:

- the amount of general educational development and specific vocational preparation a worker must have.
- the specific capacities and abilities required of the worker in order to learn or perform certain tasks or duties.
- preferences for certain types of work activities or experiences considered necessary for job success.
- types of occupational situations to which an individual must adjust.
- physical activities required in work situations.
- physical surroundings prevalent in jobs.

All of this information can be used for placing students in or orienting them to the training program, when used in conjunction with the General Job Description (Section 1.3) and the Inventory of Job Tasks and Learning Objectives (Section 1.4).

QUALIFICATIONS PROFILE

The qualifications listed for successful performance as an entry-level business machine repairer are minimally acceptable standards of accomplishment necessary at that level.* (Section 2.5, "Worker Trait Codification System," presents a complete explanation of the levels and codification system used.)

The qualifications listed do not relate to performance requirements existing at higher levels within the career field. In order to progress within the field, the student must have the ability to attain higher-level capabilities through a combination of training and work experience so as to progress up the career ladder.

General Educational Development (GED) Requirements

Reasoning Development, Level 3:

Applies common-sense understanding to carry out instructions furnished in written, oral, or diagrammatic form. Deals with problems involving several concrete variables in or from standardized situations.

Mathematical Development, Level 3:

Make arithmetic calculations involving fractions, decimals, and percentages.

Language Development, Level 3:

Reading. Read a variety of novels, magazines, atlases, and encyclopedias. Read safety rules and instructions.

Writing. Write reports and essays with proper format, punctuation, spelling, and grammar, using all parts of speech.

Speaking. Speak before an audience with poise, voice control, and confidence, using correct English and a well-modulated voice.

* It was necessary at times to update and/or modify the Department of Labor information in order to reflect new employment conditions and the realities of training. However, the basic organization and intent of the system developed by the Department of Labor and reflected in the Dictionary of Occupational Titles has been carefully followed. Critical commentary dealing with the development and utilization of the D.O.T. documents points to certain unavoidable limitations, as well as to strengths. An intent to avoid the former and take advantage of the latter underlies the development of the guide and accounts for the modifications of this information.

Specific Vocational Preparation (SVP) Requirements

Level 6: Possesses training over one year up to and including two years so as to perform assigned duties in the organization, to gain knowledge and experience for promotion to next level positions. Observes techniques utilized by experienced workers, learns line and staff functions of each department, and becomes familiar with management policies and viewpoints as they affect each phase of operations.

Aptitude (APT) Requirements

**Intelligence (G),
Level 3 Capability:**

General learning ability. The ability to "catch on" or understand instructions and underlying principles. Ability to reason and make judgments. Closely related to doing well in school.

**Verbal (V),
Level 3 Capability:**

Ability to understand meanings of words and ideas associated with them, and to use them effectively. Ability to comprehend language, to understand relationships between words, and to understand meanings of whole sentences and paragraphs. Ability to present information or ideas clearly.

**Motor Coordination (K),
Level 2 Capability:**

Ability to coordinate eyes and hands or fingers rapidly and accurately in making precise movements with speed. Ability to make a movement response accurately and quickly.

**Finger Dexterity (F),
Level 3 Capability:**

Ability to move the fingers and manipulate small objects with the fingers rapidly or accurately.

**Manual Dexterity (M),
Level 2 Capability:**

Ability to move the hands easily and skillfully. Ability to work with the hands in placing and turning motions.

Interest (INT) Requirements

Factor 1: Situations involving activities dealing with things and objects.

is preferred over

Factor 6: Situations involving activities concerned with people and the communication of ideas.

Factor 0: Situations involving activities resulting in tangible, productive satisfaction.

is preferred over

Factor 5: Situations involving activities resulting in prestige or the esteem of others.

Temperaments (TEMP) Requirements

- | | |
|--------------------------|--|
| Situation Type 1: | Situations involving a variety of duties often characterized by frequent change. |
| Situation Type 2: | Situations involving repetitive or short-cycle operations carried out according to set procedures or sequences. |
| Situation Type 0: | Situations involving the evaluation (arriving at generalizations, judgments, or decisions) of information against measurable or verifiable criteria. |
| Situation Type Y: | Situations involving the precise attainment of set limits, tolerances, or standards. |

Physical Demands

Medium work involving the lifting of 50 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 25 lbs., associated primarily with:

- | | |
|------------------|---|
| Factor 1: | Lifting, Carrying, Pushing, and/or Pulling (strength) |
| Factor 4: | Reaching, Handling, Fingering, and/or Feeling |

Working Conditions

Work is performed inside in a constant environment without temperature change. Minor hazards are present due to working with electrical systems and proximity to moving parts.

SECTION 2.4

The Advanced General Education Program

The Advanced General Education Program is designed to teach an individual the information, concepts, and general knowledge required to pass the American Council on Education's High School General Education Development (GED) Test. All students who enter a training program with, or who subsequently attain, qualifying scores on the Advanced Stanford Achievement Test should be encouraged to enter and complete this program if they do not have the prerequisite GED level required for effective performance in the training program. See Section 2.2 for information on determining the GED (General Educational Development) level of students.

The Advanced General Education Program provides comprehensive self-instruction in each of the following areas: correctness and effectiveness of expression, interpretation of literary materials, social studies, natural sciences, and general mathematics.

It should be stressed that the program is very comprehensive and will meet the learning needs of the vast majority of students who qualify for participation (those who have a sixth-grade mathematics and a sixth-grade reading ability as a minimum).

The program has been designed to require little routine teacher attention. Instructions for placement of materials are included in a teacher's manual along with detailed administrative directions. Once students have become familiar with

this placement and with the procedures for taking the lessons and grading their own mastery tests, instructor assistance should be required only when students encounter difficulties they cannot themselves resolve and when progress is to be recorded.

The curriculum of the Advanced General Education Program is designed to provide the student with an educational background equivalent to that obtained in the typical high school course of studies, on which the standard high school achievement tests are based.

Emphasis in training is placed on learning concepts, rather than on the test-taking skills which are taught incidentally. The program prepares the student by improving his or her reading ability, increasing vocabulary, providing experience at interpretive tasks, and making him or her broadly familiar with the subject areas covered by the curriculum.

Flexible administration of the program has been accomplished in two primary ways: (1) lesson units do not take more than an hour to complete and (2) periodic screening tests enable the student to either by-pass material he or she may already know or to repeat materials that he or she did not learn sufficiently well. The time required to complete all of the lesson materials in the Advanced General Education Program averages 145 hours with a range of 90 to 230 hours.

Below is a complete listing of program materials in the Advanced General Education Program, which can be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

* This section has been excerpted from "Advanced General Education Development—A High School Self-Study Program," U.S. Dept. of Labor, Manpower Administration, Job Corps.

TEACHER'S ADMINISTRATIVE MATERIALS

Teacher's Manual
Teacher's Answer Key
Progress Flow Chart

STUDENTS' INTRODUCTORY AND SELF-ADMINISTERED TEST MATERIALS

Student's Handbook
Screening Tests
Unit Tests
Students' Answer Keys

SEQUENCE OF LESSONS IN ADVANCED GENERAL EDUCATION PROGRAM

Level I

- Unit 1: Word Roots, Prefixes, Suffixes
Word Context Clues
- Unit 2: Map Reading Skills
Climate
Studying Man and the Natural World
Man and His Culture
Reading for Implied Meanings
- Unit 3: Production and Consumption
Forms of Government
Reading for Facts, Opinions, and Issues
- Unit 4: Basic Economic Systems
Representative Democracy and Political Parties
Reading to Draw Inferences
- Unit 5: Craftsmanship and Technology
Government Separation of Powers
Comparisons in Literature
- Unit 6: Positive and Negative Numbers
States of Matter: Solid, Liquid, Gas
Properties and Measures of Matter
Energy, Matter, Theory and Law
The Particles and Structure of Matter

Unit 7: Atomic Structure and Chemical Change
Chemical Compounds
Forms of Energy

Unit 8: Solving Fraction Word Problems
Solving Decimal Word Problems
Solving Percentage Word Problems

Level II

Unit 1: Tables and Graphs
Line Graphs

Unit 2: U.S. Colonization to Independence
U.S. Confederation to Constitutional Convention
Framing the U.S. Constitution
Founding Fathers
The Election Process
The Civil War

Unit 3: Industrialization and Growth of the Cities
Immigration
Unions and Management

Unit 4: Reading for Feelings
Reading for Shifts in Feeling
Reading for Character
Reading for Signs of Hidden Character

Unit 5: Words that Paint Pictures
Devices Used in Literature
The Meaning of Literary Devices
Periods and Levels of Writing
Qualities of Good and Bad Writing

Unit 6: What to Look for in Narrative Writing
Interpreting Figurative Writing
Keeping Track of the Subject in Writing
Reading Literature for Understanding

Unit 7: Life Functions and Cells
Cell Structure
Tissues, Organs, Systems
Growth and Nutrition
Metabolism

- Unit 8: Algebra
Powers and Roots
Geometry
Number Series
- Unit 9: Speed, Acceleration, and Velocity
Force, Mass, and Distance
Types of Motion and Rest
Electricity and Magnetism
Electrical, Magnetic, and Gravitational Fields
The Conservation and Conversion of Energy
Simple Machines and Work
Gas Laws
Principles of Heat Engines
Sound and Sound Waves
Light Waves and Particles
The Behavior of Light Rays
- Unit 10: Atomic Structure and Valence
Chemical Bonding
The Table of Elements
Electrolysis
Osmosis

Level III

- Unit 1: Free Enterprise and Government Regulation
Social Legislation
Taxes
- Unit 2: Free Trade and Tariffs
Capitalism, Communism, Socialism
Nationalism vs. Internationalism
- Unit 3: Plants and Photosynthesis
The Human Digestive System
Functions of the Blood
Human Circulation and Respiration
Reproduction of a Single Cell
Reproduction by Male and Female Cells
The Human Reproductive System
Genetics and Heredity
The Nervous System
The Glandular System

- Unit 4:** Difficult Words to Spell
Sentences and Their Parts
Adjectives and Adverbs
Comparative Forms
Spelling ie and ei Words
Using Negatives Correctly
Using Prepositions and Prepositional Phrases
Spelling ance and ence Words
Subject and Object Pronouns
Possessive and Reflexive Pronouns
Possessive and Plural Nouns
Spelling Confusing Word Pairs
Subject and Verb Agreement
Past Verb Forms
Spelling More Difficult Words
- Unit 5:** Spelling Endings Added to e
Capitalization
Question Marks and Exclamation Points
Quotation Marks
Spelling Double Letter Demons
Colons and Dashes
Punctuating Series with Commas and Semicolons
More Confusing Word Pairs
Separating Sentence Parts with Punctuation
Other Uses for Commas and Semicolons
More Special Spelling Problems
- Unit 6:** Spelling More Endings
Matching Sentence Parts
Using the Right Sentence Connectives
More Ways to Make Sentences Effective
Last of the Confusing Word Pairs

SECTION 2.5

Worker Trait Codification System

Worker traits can be defined as those abilities, personal traits, and individual characteristics required for a worker to achieve average successful job performance. This section provides detailed explanations of these worker traits and their levels: General Educational Development, Specific Vocational Preparation, Aptitudes, Interests, Temperaments, and Physical Demands.

This section also provides an explanation of the last three digits of the occupational code numbers used in the Dictionary of Occupational Titles: namely, the relationship of any particular job to Data, People, and Things. All of the information in Section 2.5 has been excerpted from Appendices A and B of the Dictionary of Occupational Titles, Volume II.

GENERAL EDUCATIONAL DEVELOPMENT (GED)

General Educational Development embraces the aspects of education, both formal and informal, which contribute to the worker's reasoning development, ability to follow instructions, and acquisition of "tool" knowledges such as language and mathematical skills. It is education of a general nature which does not have a

recognized, fairly specific, occupational objective. Ordinarily such education is obtained in elementary school, high school, or college. It also derives from experience and from individual study. The table on the next page explains the various levels of General Educational Development.

SPECIFIC VOCATIONAL PREPARATION (SVP)

Specific Vocational Preparation includes the amount of time required to learn the techniques, acquire the information, and develop the facility needed for average performance in a specific job-worker situation. This training may be acquired in a school, work, military, institutional, or avocational environment. It does not include the orientation training required of every fully qualified worker to become accustomed to the special conditions of any new job. Specific Vocational Preparation includes training given in any of the following circumstances:

- vocational education such as high school commercial or shop training, technical school, art school, and that part of college training which

is organized around a specific vocational objective.

- apprentice training, for apprenticeable jobs only.
- in-plant training given by an employer in the form of organized classroom study.
- on-the-job training under the instruction of a qualified worker.
- essential experience in other, less responsible jobs which lead to the higher-level job, or serving in other jobs which qualify.

GENERAL EDUCATIONAL DEVELOPMENT

Level	Reasoning Development	Mathematical Development	Language Development
6	Apply principles of logical or scientific thinking to a wide range of intellectual and practical problems. Deal with non-verbal symbolism (formulas, scientific equations, musical notes, graphs, etc.) in its most difficult phases. Deal with a variety of abstract and concrete variables. Apprehend the most abstruse classes of concepts.	Apply knowledge of advanced mathematical and statistical techniques such as differential and integral calculus, factor analysis, and probability determination, or work with a wide variety of theoretical mathematical concepts and make original applications of mathematical procedures, as in empirical and differential equations.	Comprehension and expression of a level to: ● Report, write, or edit articles for such publications as newspapers, magazines, and technical or scientific journals. ● Prepare and deliver lectures on politics, economics, education, or science. ● Interview, counsel, or advise such people as students, clients, or patients in such matters as welfare eligibility, vocational rehabilitation, mental hygiene, or marital relations.
5	Apply principles of logical or scientific thinking to define problems, collect data, establish facts, and draw conclusions. Interpret an extensive variety of technical instructions in books, manuals, and mathematical or diagrammatic form. Deal with several abstract and concrete variables.	Perform ordinary arithmetic, algebraic and geometric procedures in standard, practical applications.	Comprehension and expression of a level to: ● Transcribe dictation, make appointments for executive and handle personal mail, interview and screen people, and write routine correspondence on own initiative. ● Interview j.b applicants to determine work best suited for their abilities and experience, and contact employers to interest them in services of agency. ● Interpret technical manuals as well as drawings and specifications, such as layouts, blueprints, and schematics.
4	Apply principles of rational systems to solve practical problems and deal with a variety of concrete variables in situations where only limited standardization exists. Interpret a variety of instructions furnished in written, oral, diagrammatic, or schedule form.	Make arithmetic calculations, involving fractions, decimals, and percentages.	Comprehension and expression of a level to: ● File, post, and mail such material as forms, checks, receipts, and bills. ● Copy data from one record to another, fill in report forms, and type all work from rough draft or corrected copy. ● Interview members of household to obtain such information as age, occupation, and number of children, to be used as data for surveys or economic studies. ● Guide people on tours through historical or public buildings, describing such features as size, value, and points of interest.
3	Apply common sense understanding to carry out instructions furnished in written, oral, or diagrammatic form. Deal with problems involving several concrete variables in or from standardized situations.	Use arithmetic to add, subtract, multiply, and divide whole numbers.	Comprehension and expression of a level to: ● Learn job duties from oral instructions or demonstration. ● Write identifying information, such as name and address of customer, weight, number, or type of product, on tags or slips. ● Request orally or in writing such supplies as linen, soap, or work materials.
2	Apply common sense understanding to carry out detailed but uninvolved written or oral instructions. Deal with problems involving a few concrete variables in or from standardized situations.	Perform simple addition and subtraction, reading and copying of figures, or counting and recording.	
1	Apply common sense understanding to carry out simple one- or two-step instructions. Deal with standardized situations with occasional or no variables in or from these situations encountered on the job.		

The following table describes the nine levels of Specific Vocational Preparation:

<u>Level</u>	<u>Time</u>
1	Short demonstration only
2	Anything beyond short demonstration up to and including 30 days
3	Over 30 days up to and including three months
4	Over three months up to and including six months
5	Over six months up to and including one year
6	Over one year up to and including two years
7	Over two years up to and including four years
8	Over four years up to and including 10 years
9	Over 10 years

APTITUDES (APT)

The five-point scale below indicates how much of each aptitude the job requires for satisfactory or average performance. The average requirements, rather than a maximum or minimum, are cited. The amount required is expressed in terms of equivalent amounts possessed by segments of the general working population. The five-point scale is as follows:

- 1 = The top 10 percent of the population. This segment of the population possesses an extremely high degree of the aptitude.
- 2 = The highest third exclusive of the top 10 percent of the population. This segment of the population possesses an above-average or high degree of the aptitude.

3 = The middle third of the population. This segment of the population possesses a medium degree of the aptitude, ranging from slightly above to slightly below average.

4 = The lowest third exclusive of the bottom 10 percent of the population. This segment of the population possesses a below-average or low degree of the aptitude.

5 = The lowest 10 percent of the population. This segment of the population possesses a negligible degree of the aptitude.

This scale can be applied to each of the 11 aptitudes below to indicate the amount required for a particular job or task. The code letters used to designate each aptitude are in parentheses.

DESCRIPTION OF APTITUDES

Intelligence (G): General learning ability. The ability to "catch on" or understand instructions and underlying principles. Ability to reason and make judgments. Closely related to doing well in school.

Verbal (V): Ability to understand meanings of words and ideas associated with them, and to use them effectively. Ability to comprehend language, to understand relationships between words, and to understand meanings of whole sentences and paragraphs. Ability to present information or ideas clearly.

Numerical (N): Ability to perform arithmetic operations quickly and accurately.

Spatial (S): Ability to comprehend forms in space and understand relationships of plane and solid objects. May be used in such tasks as blueprint reading and in solving geometry problems. Frequently described as the ability to "visualize" objects of two or three dimensions, or to think visually of geometric forms.

Form Perception (P): Ability to perceive pertinent detail in objects or in pictorial or graphic material. Ability to make visual comparisons and discriminations and see slight differences in shapes and shadings of figures and widths and lengths of lines.

Clerical Perception (Q): Ability to perceive pertinent detail in verbal or tabular material. Ability to observe differences in copy, to proofread words and numbers, and to avoid perceptual errors in arithmetic computation.

Motor Coordination (K): Ability to coordinate eyes and hands or fingers rapidly and accurately in making precise movements with speed. Ability to make a movement response accurately and quickly.

Finger Dexterity (F): Ability to move the fingers and to manipulate small objects with the fingers rapidly or accurately.

Manual Dexterity (M): Ability to move the hands easily and skillfully. Ability to work with the hands in placing and turning motions.

Eye-Hand-Foot Coordination (E): Ability to move the hand and foot coordinately with each other in accordance with visual stimuli.

Color Discrimination (C): Ability to perceive or recognize similarities or differences in colors, or in shades or other values of the same color. Ability to identify a particular color, or to recognize harmonious or contrasting color combinations, or to match colors accurately.

INTERESTS (INT)

This worker trait component involves preferences for certain types of work activities or experiences, with accompanying rejection of contrary types of activities or experiences. Five pairs of interest factors are provided so that a positive preference for one factor of a pair also implies rejection of the other factor of that pair.

1 Situations involving a preference for activities dealing with things and objects.

vs.

6 Situations involving a preference for activities concerned with people and the communication of ideas.

- | | | | | |
|---|--|-----|---|---|
| 2 | Situations involving a preference for activities involving business contact with people. | vs. | 7 | Situations involving a preference for activities of a scientific and technical nature. |
| 3 | Situations involving a preference for activities of a routine, concrete, organized nature. | vs. | 8 | Situations involving a preference for activities of an abstract and creative nature. |
| 4 | Situations involving a preference for working with people for their presumed good, as in the social welfare sense, or for dealing with people and language in social situations. | vs. | 9 | Situations involving a preference for activities that are nonsocial in nature, and are carried on in relation to processes, machines, and techniques. |
| 5 | Situations involving a preference for activities resulting in prestige or the esteem of others. | vs. | 0 | Situations involving a preference for activities resulting in tangible, productive satisfaction. |

TEMPERAMENTS (TEMP)

Temperaments refer to different types of occupational situations to which workers must adjust.

- | | | | |
|---|---|---|--|
| 1 | Situations involving a variety of duties often characterized by frequent change. | 7 | Situations involving influencing people in their opinions, attitudes, or judgments about ideas or things. |
| 2 | Situations involving repetitive or short cycle operations carried out according to set procedures or sequences. | 8 | Situations involving performing adequately under stress when confronted with the critical or unexpected or when taking risks. |
| 3 | Situations involving doing things only under specific instruction, allowing little or no room for independent action or judgment in working out job problems. | 9 | Situations involving the evaluation (arriving at generalizations, judgments, or decisions) of information against sensory or judgmental criteria. |
| 4 | Situations involving the direction, control, and planning of an entire activity or the activities of others. | 0 | Situations involving the evaluation (arriving at generalizations, judgments, or decisions) of information against measurable or verifiable criteria. |
| 5 | Situations involving the necessity of dealing with people in actual job duties beyond giving and receiving instructions. | X | Situations involving the interpretation of feelings, ideas, or facts in terms of personal viewpoint. |
| 6 | Situations involving working alone and apart in physical isolation from others, although the activity may be integrated with that of others. | Y | Situations involving the precise attainment of set limits, tolerances, or standards. |

PHYSICAL DEMANDS (PHYS DEM)

Physical demands are those physical activities required of a worker in a job. The physical demands referred to serve as a means of expressing both the physical requirements of the job and the physical capacities (specific physical traits) a worker must have to meet the requirements. For example, "seeing" is the name of a physical demand required by many jobs (perceiving by the sense of vision), and also the name of a specific capacity possessed by many people (having the power of sight). The worker must possess physical capacities at least in an amount equal to the physical demands made by the job.

FACTOR 1: Lifting, Carrying, Pushing, and/or Pulling (Strength)

These are the primary "strength" physical requirements, and generally speaking, a person who engages in one of these activities can engage in all. Specifically, each of these activities can be described as:

Lifting: Raising or lowering an object from one level to another (includes upward pulling).

Carrying: Transporting an object, usually holding it in the hands or arms or on the shoulder.

Pushing: Exerting force upon an object so that the object moves away from the force (includes slapping, striking, kicking, and treadle actions).

Pulling: Exerting force upon an object so that the object moves toward the force (includes jerking).

The five degrees of Factor 1: Lifting, Carrying, Pushing, and/or Pulling are as follows:

Sedentary Work (S) = Lifting 10 lbs. maximum and occasionally lifting and/or carrying such

articles as dockets, ledgers, and small tools. Although a sedentary job is defined as one which involves sitting, a certain amount of walking and standing is often necessary in carrying out job duties. Jobs are sedentary if walking and standing are required only occasionally and other sedentary criteria are met.

Light Work (L) = Lifting 20 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 10 lbs. Even though the weight lifted may be only a negligible amount, a job is in this category when it requires walking or standing to a significant degree, or when it involves sitting most of the time with a degree of pushing and pulling of arm and/or leg controls.

Medium Work (M) = Lifting 50 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 25 lbs.

Heavy Work (H) = Lifting 100 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 50 lbs.

Very Heavy Work (V) = Lifting objects in excess of 100 lbs. with frequent lifting and/or carrying of objects weighing 50 lbs. or more.

FACTOR 2: Climbing and/or Balancing

Climbing: Ascending or descending ladders, stairs, scaffolding, ramps, poles, ropes, and the like, using the feet and legs and/or hands and arms.

Balancing: Maintaining body equilibrium to prevent falling when walking, standing, crouching, or running on narrow, slippery, or erratically moving surfaces; or maintaining body equilibrium when performing gymnastic feats.

**FACTOR 3: Stooping, Kneeling,
Crouching, and/or Crawling**

Stooping: Bending the body downward and forward by bending the spine at the waist.

Kneeling: Bending the legs at the knees to come to rest on the knee or knees.

Crouching: Bending the body downward and forward by bending the legs and spine.

Crawling: Moving about on the hands and knees or hands and feet.

**FACTOR 4: Reaching, Handling,
Fingering, and/or Feeling**

Reaching: Extending the hands and arms in any direction.

Handling: Seizing, holding, grasping, turning, or otherwise working with the hand or hands (fingering not involved).

Fingering: Picking, pinching, or otherwise working with the fingers primarily (rather than with the whole hand or arm as in handling).

Feeling: Perceiving such attributes of objects and materials as size, shape, temperature, or texture, by means of receptors in the skin, particularly those of the fingertips.

FACTOR 5: Talking and/or Hearing

Talking: Expressing or exchanging ideas by means of the spoken word.

Hearing: Perceiving nature of sounds by the ear.

FACTOR 6: Seeing

Obtaining impressions through the eyes of the shape, size, distance, motion, color, or other characteristics of objects. The major visual functions are defined as follows:

Acuity, Far: Clarity of vision at 20 feet or more.

Acuity, Near: Clarity of vision at 20 inches or less.

Depth Perception: Three-dimensional vision. The ability to judge distance and space relationships so as to see objects where and as they actually are.

Field of Vision: The area that can be seen up and down or to the right or left while the eyes are fixed on a given point.

Accommodation: Adjustment of the lens of the eye to bring an object into sharp focus. This item is especially important when doing near-point work at varying distances from the eye.

Color Vision: The ability to identify and distinguish colors.

DATA, PEOPLE, AND THINGS

The last three digits of an occupational code number express the job's relationship to Data, People, and Things. Only relationships which are significant in terms of job requirements are reflected in the code numbers. The incidental

relationships which every worker has to Data, People, and Things, but which do not seriously affect successful performance of the essential duties of the job, are not reflected. Each successive relationship includes those that are simpler.

DATA (4th digit)

- 0 Synthesizing
- 1 Coordinating
- 2 Analyzing
- 3 Compiling
- 4 Computing
- 5 Copying
- 6 Comparing
- 7 No significant relationship
- 8 No significant relationship

PEOPLE (5th digit)

- 0 Mentoring
- 1 Negotiating
- 2 Instructing
- 3 Supervising
- 4 Diverting
- 5 Persuading
- 6 Speaking-Signalling
- 7 Serving
- 8 No significant relationship

THINGS (6th digit)

- 0 Setting Up
- 1 Precision Working
- 2 Operating-Controlling
- 3 Driving-Operating
- 4 Manipulating
- 5 Tending
- 6 Feeding-Offbearing
- 7 Handling
- 8 No significant relationship

SECTION 2.6

Related Jobs at Entry, Intermediate, and Advanced Levels

This section is intended primarily for use in career guidance activities. Persons trained in business machine repair will acquire skills and knowledge which provide job and career mobility across a broad range of occupations. The following list of job descriptions, as a partial compilation, illustrates the career flexibility possible given continued training or a minimum amount of retraining. The job titles and code numbers have been drawn from the Dictionary of Occupational Titles, where a complete listing of related jobs can be found.

To be used effectively, this list should be matched against the Inventory of Job Tasks and Learning Objectives (Section 1.4), which has been structured by job levels (entry, intermediate, and advanced) within the career ladder. Guidance counselors, instructors and students, as well as employers, recruiting officers, placement and personnel directors, and others within education and industry should find these products of much value.

APPLIANCE-SERVICE SUPERVISOR (light, heat, and power) D.O.T. 187.168

Coordinates activities of merchandise-servicing department of gas or electric appliance distributors. Supervises, trains, and assigns duties to workers engaged in servicing appliances. Develops company policies and procedures regarding servicing of appliances and disposition of defective parts. Consults manufacturers to obtain advice on unusual service problems and to obtain service instructions and parts catalogs. Writes bulletins on care and use of appliances for distribution to public. Supervises pricing and disposition of returned merchandise and excess repair parts.

APPLIANCE REPAIRMAN (any industry)

A term applied to workers engaged in installing, servicing, and repairing electrical or gas appliances. Classifications are made according to type of appliance serviced as electrical-appliance repairman; electrical-appliance serviceman; gas-appliance serviceman; or household appliance repairman.

APPLIANCE REPAIRMAN (electrical equipment) D.O.T. 723.884

Repairs portable, household electrical appliances, such as fans, heaters, vacuum cleaners, toasters, and flatirons, on assembly line. Refers to inspector's check list or defect symbol marked on appliance to identify defective or malfunctioning part. Disassembles appliance to remove defective part, using power screwdrivers, soldering iron, and handtools. Installs new part, and reassembles appliance. Records nature of repair in log or on mechanical counting device. Maintains stock of replacement parts. May determine repair requirements by connecting appliance to power source or examining parts for defects while disassembling. May file or bend parts to remove burrs or to improve alignment and fit. May hold appliance against buffing or polishing wheel to remove scratches from metal surfaces. May touch up paint defects, using brush or spray gun. May be designated according to part repaired as heating-element repairer, or appliance repaired as electric-frying-pan repairman; food-mixer repairman; vacuum-cleaner repairman.

ELECTRICAL-APPLIANCE REPAIRMAN (any industry) D.O.T. 723.381

Repairs electrical appliances, such as toasters, cookers, percolators, lamps, and irons, using

handtools and electrical testing instruments. Examines appliance for mechanical defects and disassembles it. Tests wiring for broken or short circuits, using voltmeters, ohmmeters, and other circuit testers. Replaces defective wiring and parts, such as toaster elements and percolator coils, using handtools, soldering iron, and spot-welding equipment. May compute charges for labor and materials. May assist electrical-appliance serviceman in repairing such appliances as refrigerators and stoves.

ELECTRICAL-APPLIANCE SERVICEMAN
(any industry) D.O.T. 827.281

Installs, services, and repairs stoves, refrigerators, dishwashing machines, and other electrical household appliances, using handtools and test meters and following wiring diagrams and manufacturer's specifications. Connects appliance to power source and test meters, such as voltmeter, wattmeter, and ammeter, and observes readings on meters and graphic recorders. Observes and listens to appliance during operating cycle to detect excess vibration, overheating, fluid leaks, and loose parts. Disassembles appliance and examines mechanical and electrical parts. Traces electrical circuits, following diagram, and locates shorts and grounds, using ohmmeter. Calibrates timers and thermostats, and adjusts contact points. Cleans and washes parts, using wire brush, buffer, and solvent to remove carbon, grease, and dust. Replaces worn or defective parts, such as switches, pumps, bearings, transmissions, belts, gears, blowers, and defective wiring. Repairs and adjusts appliance motors. Reassembles appliance, adjusts pulleys, and lubricates moving parts, using handtools and lubricating equipment. May be known according to appliance repaired as clothes-drier repairman; dishwashing-machine repairman; electric-range serviceman; electric-refrigerator serviceman; or washing-machine serviceman.

ELECTRICAL-APPLIANCE-SERVICEMAN
APPRENTICE (any industry) D.O.T. 827.281

Performs duties as described under apprentice.

ELECTRICAL-APPLIANCE-SERVICEMAN
FOREMAN (any industry) D.O.T. 827.131

Supervises and coordinates activities of electrical-appliance servicemen engaged in servicing, repairing, and installing electrical household appliances. Requisitions tools, supplies, and replacement parts. Performs other duties as described under foreman.

ELECTRICAL-APPLIANCE-SERVICEMAN
HELPER (any industry) D.O.T. 827.887

Assists electrical-appliance serviceman in installing, servicing, and repairing electrical household appliances. Connects clothes drier, dishwashing machine, refrigerator, washing machine, or other appliance to current outlet. Cleans and washes parts, using wire brush, buffer, and solvent, to remove carbon, grease, and dust. Unwraps accessories, such as shelves, drain pan, and drawers, and secures them in position in appliance. Transports appliance, using handtruck. Performs other duties as described under helper.

ELECTRICAL-APPLIANCE-SET-UP MAN
(any industry) D.O.T. 827.884

Assembles and tests electrical appliances, such as ranges, refrigerators, and washing machines, to prepare them for delivery and installation, using handtools and test lamp. Uncrates appliances, using pry bar, wire cutters, and nail puller. Assembles appliance parts, using screws and handtools. Connects appliance to electric current to test performance. Locates faulty circuits with test lamp. Solders and wraps wires with friction tape to repair insulation. Washes and polishes appliances. Examines exterior of appliance for chips, scratches, and dents. Keeps records of appliances received, assembled, and delivered. May be designated according to type of appliance assembled and tested as dishwasher set-up man; electric-range set-up man; electric-refrigerator set-up man; or washer-drier set-up man.

ELECTRICAL INSPECTOR (instruments and appliances) D.O.T. 710.281

Tests electrical devices, such as immersion temperature probes, aerodynamic probes, and Pitot tubes at specified temperatures and air pressures by computing resistance, using instruments, such as bridges, galvanometer, oscilloscope, and variable-voltage power supply, according to written specifications. Immerses device in temperature baths. Attaches test equipment leads to device. Measures resistance and current of sensing element or finished device at specified temperature, using bridges, galvanometer, power supply, and oscilloscope. Computes values of required resistances, using resistance formulas. Mounts devices on holding fixture in vacuum cylinder, attaches test equipment leads, and starts vacuum pump. Tests devices to determine voltage required to break down insulation at simulated altitudes, using power supply, galvanometer, and oscilloscope. Determines resistance values at specified temperatures, using electric oven, bridges, galvanometer, and power supply. Keeps inspection records and writes procedure reports.

ELECTRICAL-INSTALLATION INSPECTOR (light, heat, and power) D.O.T. 821.131

Supervises and coordinates activities of electric-meter installer engaged in installing meters for recording electric current consumption. Reviews work orders to verify specifications of wire sizes and metering equipment according to National Electric Code and company requirements. Visits installation sites and inspects installed meters and other electrical appliances for conformance to specifications and safety standards. Consults with customers, electric-wiring contractors, and commercial department representatives to determine space requirements, the availability of customer-service outlets, and types of metering equipment for special installations. Performs other duties as described under foreman.

ELECTRICAL INSPECTOR (aircraft manufacturing) D.O.T. 825.381

Inspects and tests electrical and communication systems of aircraft for conformance to specifications, using electronic testing equipment. Reads inspection check list, work order, schematics, and blueprints to determine method of inspection. Examines wiring to detect loose connections and frayed insulation. Inspects curvature of conduit bends and location and arrangement of conduit boxes, switches, and wiring for conformance with blueprints, using scale and protractor. Switches on heater, defroster, and lights to verify operation. Observes control and indicator instruments during functional testing of mechanical systems, such as fuel, hydraulic, and landing gear, to detect malfunctions. Tests installed systems, such as radio, navigation, engine control, flight control, armament, lighting, heating, and pressurization, to determine that functions, such as power output, circuit continuity, radiation pattern, and frequency output, conform to specifications, using electronic testing equipment, such as voltmeter, ammeter, oscilloscope, and signal generator. Compiles test reports on malfunctioning units. May inspect prior to flight and be designated inspector, preflight, radio and electrical.

ELECTRICAL-EQUIPMENT TESTER (aircraft manufacturing) D.O.T. 729.381

Tests and adjusts electrical equipment and accessories to insure conformance to specifications preparatory to installation in aircraft. Examines accessories and equipment, such as alternators, batteries, bells, bomb releases, booster coils, circuit breakers, condensers, electric actuators, limit switches, solenoids, and starter control valves, for surface defects, such as rust, grease, and dirt. Connects accessories and equipment to instruments, such as voltmeter, ammeter, Wheatstone bridge, oscilloscope, and torque indicator, and tests for voltages under loads, output and input of power at various operating temperatures, amount of current used at dif-

ferent voltages, electrical leakages, short circuits and open circuits, and electric motor torques. Adjusts moving parts as indicated by tests, using handtools. Stamps or attaches tags to approved equipment. Records results of tests. May test effects of vibration on equipment and accessories, using vibration testing equipment. May design, lay out, and construct special testing jigs. May measure parts of electromechanical assemblies for conformance to specifications, using micrometers, calipers, and gages.

**ELECTRIC-EYE-SORTING-MACHINE
TECHNICIAN (canning and preserving)
D.O.T. 629.281**

Sets up, repairs, and maintains electric-eye sorting equipment that sorts vegetables according to degree of color preparatory to freezing them. Assembles components, such as piping, wiring, scanning disks, and electronic tubes, using handtools and electronic testing instruments. Devises and cuts geometric patterns and installs them in equipment to regulate sorting mechanism, using knife and other handtools. Inspects equipment and product to detect flaws in machine operation. Replaces defective parts, using wrenches, pliers, screwdrivers, and other handtools. Operates lathes, drill presses, grinders, and other metalworking tools to repair parts. Tests assembled machine, using ammeters, voltmeters, and tube and circuit testers. Prepares progress reports and recommends additional equipment, special attachments, and other changes to increase production efficiency of equipment.

**ELECTRIC-METER TESTER (light, heat,
and power) D.O.T. 821.381**

Tests accuracy of meters used for recording electric current consumption and makes necessary adjustments. (1) Connects meter to standard (specially calibrated electric meter mechanism) and adjusts standard's dials to the meter being tested. Pushes switch and allows needle on standard to revolve specified number of turns

or for clocked period. Compares meter and standard calibrated dials to ascertain accuracy of meter. (2) Connects testing instruments, such as wattmeter, voltmeter, and ammeter, across coils of meter and allows load to pass through meter for clocked period. Computes watt-hours of current consumed, using instrument readings and time factor. Compares watt-hour computations with dial on tested meter to determine meter accuracy. Adjusts meters by loosening or tightening screws, using screwdriver. Inspects wiring of installed meters for improper connections or diversions of current. May make minor repairs and recommend meter removal for major repair. May clean mechanism with solution and small brush. May calculate inaccurate meter variations from standard. May set up auxiliary equipment to route current around installed meter during testing to avoid interruption to service. Does not perform tests on inaccurate meters to diagnose malfunctioning if inaccuracy cannot be corrected by screw adjustment. May be primarily experienced in testing of direct-current meters, alternating-current meters, single-phase meters, or polyphase meters.

**ELECTROMECHANICAL INSPECTOR
(instruments and appliances) D.O.T. 710.381**

Inspects and tests electrical components, housings, and finished assemblies of electrical sensing devices for conformance with specifications, using binocular microscope, electrical test equipment, and precision measuring instruments. Examines electrical components, housings, and finished devices for defects, such as burrs, improper assembly, scratches, and welding flaws, using binocular microscope. Measures components, housings, and finished devices, using precision measuring devices such as micrometers, calipers, and go-not-go gages. Tests electrical components and finished devices, using electrical test equipment, such as ohmmeter and vacuum-tube voltmeter. Records test results for each device and writes report covering defects for rejected devices. Inspects precision measuring instruments, using standard gage blocks, and keeps file of inspection data.

ELECTROMECHANICAL TECHNICIAN
(instruments and appliances) D.O.T. 710.281

Fabricates, tests, analyzes, and adjusts precision electromechanical instruments, such as temperature probes and aerodynamic probes, following blueprints and sketches, using handtools, metalworking machines, and measuring and testing instruments. Operates metalworking machines, such as bench lathe, milling machine, punch press, and drill press, to fabricate housings, fittings, jigs, and holding fixtures, and verifies dimensions, using micrometer and calipers. Assembles wires, insulation, and electrical components, such as resistors and capacitors, following method layouts, using holding fixtures, binocular microscope, files, soldering tools, tweezers, wirecutters, pliers, and screwdriver. Installs electrical assemblies and hardware in housing, using handtools and soldering equipment. Tests assembled instruments for circuit continuity and operational reliability, using multimeter, oscilloscope oscillator, vacuum tube voltmeter, and bridge. Analyzes test results and repairs or adjusts instruments according to analysis. Records test results and writes report on fabrication techniques used. May specialize in assembly of prototype instruments and be designated development technician, or in assembly of production instruments and be designated fabrication technician.

ELECTROMEDICAL-EQUIPMENT REPAIRMAN (any industry) D.O.T. 729.281

Tests and repairs electromedical equipment, such as electrocardiographs, electroencephalographs, sterilizers, operating room lamps and tables, and diathermy machines, following schematic diagrams and using handtools and test meters. Tests electrical circuits and components to locate shorts, faulty connections, and defective parts, using test meters. Solders loose connections and replaces defective parts, such as tubes, transformers, resistors, condensers, and switches, using handtools and soldering iron. Disassembles equipment and repairs or replaces faulty mechanical parts, such as control lever mechanisms and water impellers. Adjusts and repairs stylus,

graph, and other recording mechanisms. May replace X-ray tubes. May operate engine lathe to shape replacement parts, such as pins or screws. May be designated according to type of machine or equipment repaired as diathermy-equipment repairman; electrocardiograph repairman.

ELECTRONIC-SALES-AND-SERVICE TECHNICIAN (professional and kindred occupations) D.O.T. 828.251

Analyzes technical requirements of customer desiring to utilize electronic equipment, and performs installation and maintenance duties. Determines feasibility of using standardized equipment and develops specifications for equipment required to perform additional functions. Installs, maintains, and repairs equipment.

HOUSEHOLD-APPLIANCE-INSTALLATION MAN (any industry) D.O.T. 827.381

Installs household appliances, such as refrigerators, washing machines, stoves, and television receiving sets, in customers' homes, using handtools. Levels refrigerators and adjusts doors. Connects water pipes to washing machines, using plumbing tools. Observes complete cycle of automatic washers and dryers and makes adjustments. Lights and adjusts pilot lights on gas stoves and examines valves and burners for gas leakage and specified flame. Connects television sets and adjusts dials and antennas to obtain clear picture on channels. May install television converters and antennas.

HOUSEHOLD-APPLIANCE REPAIRMAN (any industry) D.O.T. 827.281

Repairs gas and electric appliances and equipment, such as refrigerators, ranges, washing machines, hot-water heaters, toasters, and irons, using handtools. Disassembles appliances and examines parts for defects. Repairs defective parts, using handtools. Advises customer on use and care of appliance. May estimate cost of repairs. May install appliances.

OFFICE-MACHINE SERVICEMAN
(any industry) D.O.T. 633.281

Repairs and services office machines, such as adding, accounting, and calculating machines, and typewriters, using handtools, power tools, micrometers, and welding equipment. Operates machines to test moving parts and to listen to sounds of machines to locate causes of trouble. Disassembles machine and examines parts, such as gears, guides, rollers, and pinions, for wear and defects, using micrometers. Repairs, adjusts, or replaces parts, using handtools, power tools, and soldering and welding equipment. Cleans and oils moving parts. May give instructions on operation and care of machines to machine operators. May assemble new machines. May be designated according to machine repaired or serviced as accounting-machine serviceman; adding-machine serviceman; calculating-machine serviceman; duplicating-machine serviceman; or typewriter serviceman.

OFFICE-MACHINE-SERVICEMAN FOREMAN
(any industry) D.O.T. 633.131

Supervises and coordinates activities of workers engaged in serving, repairing, and rebuilding

office machines, such as calculating, tabulating, bookkeeping, duplicating machines, and typewriters, in customer's establishment and in repair shop. May review reports on unserviceable machines and examine them to determine repairs required and to estimate cost of repair. May compute cost of repaired items. Performs duties as described under foreman. When supervising workers in repair shop, may be designated office-machine-repair-shop foreman.

VENDING-MACHINE REPAIRMAN
(business services) D.O.T. 639.381

Installs and repairs vending machines, using handtools and power tools. Assembles new machines and fills them with ingredients or products for testing. Tests ice making, refrigeration, carbonation, and evaporation systems. Tests dispensing, electrical, and coin handling systems. Corrects malfunctions, using handtools. Transports machine to location and connects water, electricity, and drains. Repairs machines on location or at shop. Removes dents from cabinets, welds broken brackets, and installs new panels, using handtools and welding equipment.

SECTION 2.7

Related Jobs by Worker Trait Group

This section is intended primarily for use in career guidance activities. The lists of jobs presented here are categorized according to the principal worker trait groups associated with the business machine repair career field: .281, .381 (Craftsmanship and Related Work). These groups are an important component of the qualifications profile and the inventory of job tasks and learning objectives. Jobs are arranged numerically according to their complete Dictionary

of Occupational Titles (D.O.T.) code number. (See Section 2.5 for an explanation of the codification system used in the D.O.T.) The jobs listed may be drawn from any number of three-digit groups within each Occupational Group Arrangement. This section presents only the base and defined related titles. For a complete listing of all undefined, related, and alternate job titles within each Occupational Group Arrangement, the user is directed to the D.O.T.

WORKER TRAIT GROUPS .281, .381: CRAFTSMANSHIP AND RELATED WORK

60 Metal Machining

- 600. **Machining and Related Work**
- 600.281 Assembler, Steam-and-Gas Turbine (engine and turbine)
- 600.381 Lay-Out Man (machine shop)

- 601. **Toolmaking and Related Work**
- 601.281 Inspector, Gage (machine shop)
- Inspector, Set-Up and Lay-Out Man (machine shop)

62 Mechanical Repairing

- 620. **Motorized Vehicle and Engineering Equipment Repairing**
- 620.281 Air-Conditioning Mechanic (automotive servicing)
- Automotive-Maintenance-Equipment Serviceman (any industry)

- 621. **Aircraft Repairing**
- 621.281 Aircraft-and-Engine Mechanic (aircraft manufacturing, air transportation)
- 621.381 Pneumatic Tester and Mechanic (aircraft manufacturing)

- 622. **Rail Equipment Repairing**
- 622.381 Air-Valve Repairman (locomotive and car building and repair)

623. **Marine Equipment Repairing**
 623.281 Machinist, Marine Engine (ship and boat building and repair)
624. **Farm Machinery Repairing**
 624.281 Farm-Equipment Mechanic (agriculture)
627. **Printing and Publishing Machinery Repairing**
 627.281 Press-Maintenance Man (printing and publishing)
629. **Special Industry Machinery Repairing**
 629.281 Electric-Eye-Sorting-Machine Technician (canning and preserving)
 Maintenance Man, Television Picture Tubes (electronics)
 Maintenance Mechanic, Record Process Equipment (phonograph)
- 63 Mechanical Repairing**
630. **General Industry Machinery Repairing**
 630.281 Mechanical Inspector (petroleum refining)
 630.381 Conveyor-Maintenance Man (any industry)
 Lubrication-Equipment-Maintenance Man (any industry)
633. **Business and Commercial Machine Repairing**
 633.281 Assembly Technician (office machines)
 Cash-Register Serviceman (any industry)
 Dictating-Transcribing-Machine Serviceman (any industry)
 Machine Analyst (office machines)
 Mail-Processing Equipment Mechanic (government service)
 Office-Machine Serviceman (any industry)
 Office-Machine-Serviceman Apprentice (any industry)
 Scale Mechanic (any industry)
 Statistical-Machine Serviceman (any industry)
637. **Utility Equipment Repairing**
 637.281 Air-Conditioning Mechanic, Commercial (any industry)
 Gas-Appliance Serviceman (any industry)
638. **Miscellaneous Machine Installation and Repairing**
 638.281 Automated Equipment Engineer-Technician (machine manufacturing)
 Manufacturer's Service Representative (machine manufacturing)
639. **Mechanical Repairing, not elsewhere classified**
 639.281 Coin-Machine Serviceman (business services)
 Sewing-Machine Repairman (any industry)
 639.381 Vending-Machine Repairman (business services)

- 70 Fabrication, Assembly, and Repair of Metal Products**
706. **Metal Unit Assembling and Adjusting, not elsewhere classified**
706.281 Inspector, Typewriter Assembly and Parts (typewriters and parts)
706.381 Adjuster (typewriters and parts)
 Aliner (typewriters and parts)
 Final Assembler (office machines)
 Utility Man (typewriters and parts)
- 71 Fabrication and Repair of Scientific and Medical Apparatus, Photographic and Optical Goods, Watches and Clocks, and Related Products**
710. **Fabrication and Repair of Instruments for Measuring, Controlling, and Indicating Physical Characteristics**
710.281 Electrical Inspector (instruments and appliances)
 Electro-Mechanical Technician (instruments and appliances)
 Instrument Repairman (any industry)
714. **Fabrication and Repair of Photographic Equipment and Supplies**
714.281 Technical-Maintenance Man (any industry)
- 72 Assembly and Repair of Electrical Equipment**
720. **Assembly and Repair of Radio and Television Receiving Sets and Phonographs**
720.281 Radio Repairman (any industry)
 Tape-Recorder Repairman (any industry)
 Television Service and Repairman (any industry)
721. **Assembly and Repair of Motors, Generators, and Related Products**
721.281 Electric-Motor Analyst (any industry)
 Tester, Motors and Controls (electrical equipment)
723. **Assembly and Repair of Electrical Appliances and Fixtures**
723.381 Electrical-Appliance Repairman (any industry)
729. **Assembly and Repair of Electrical Equipment, not elsewhere classified**
729.281 Audio-Video Repairman (any industry)
 Electromedical-Equipment Repairman (any industry)
- 80 Metal Fabricating, not elsewhere classified**
806. **Transportation Equipment Assembling and Related Work**
806.281 Dynamometer Tester, Motor (automobile manufacturing)
806.381 Assembler, Electro-Mechanical (aircraft manufacturing)

82 Electrical Assembling, Installing, and Repairing

**820. Generator, Motor, and Related Powerplant Equipment Assembly,
 Installation, and Repair**

820.281 Circuit-Breaker Mechanic (light, heat, and power)

820.381 Electric-Motor-Generator-Set Assembler (electrical equipment)

**822. Wire Communication, Detection, and Signaling Equipment Assembly,
 Installation, and Repair**

822.281 Central Office Repairman (telephone and telegraph)

Equipment Inspector (telephone and telegraph)

**827. Large Household Appliance and Similar Commercial and Industrial
 Equipment Assembly, Installation, and Repair**

827.281 Electrical-Appliance Serviceman (any industry)

96 Production and Distribution of Utilities

960. Production and Distribution of Gas

960.281 Field-Mechanical-Meter Tester (light, heat, and power)